AMERICAN ENGINEER
CAR BUILDER AND RAILROAD JOURNAL.

JULY, 1897.

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MASTER CAR BUILDERS' ASSOCIATION—PROCEEDINGS OF THE THIRTY-FIRST ANNUAL CONVENTION.

The Thirty-First Annual Convention of the Master Car Builders' Association was called to order in Hotel Chamberlin, Old Point Comfort, Va., at 10 a. m. June 8, 1897, President S. A. Crone in the chair, and with an unusually large attendance.

The opening prayer was delivered by Rev. W. F. Shepard. and welcome to Old Point Comfort was given in a few hearty words by Col. Royal T. Frank, First United States Artillery, Commandant of Fortress Monroe. The President then introduced the Hon. Chas. D. O'Ferrall, Governor of Virginia, who addressed the convention in a happy manner, in which a high tribute was paid to the part taken by the mechanic in the progress of the world, not only with reference to transportation, but in his general influence over all industrial affairs. The mechanic was depended upon for progress in time of peace and for the defense of the country in time of war. A moving railroad train was the greatest wonder of the time and it was the result of a gradual advance from the crudest methods and appliances. The abridging of distance was, next to the printing press and the telegraph, the most important improvement of the age. A tribute was paid to the railroads for contributing to the high standing of this country in population and commerce and in this a large share was due to the car builders for their work in rendering travel safe. His closing words were of hearty welcome. The address was thoroughly enjoyed and frequently applauded.

The President called upon Mr. J. N. Barr to respond to Governor O'Ferrall. Mr. Barr's remarks were exceedingly appropriate, and were well received.

The minutes of the previous meeting were disposed of, after which the presidential address wes delivered by Mr. Crone. The effect of the new interchange rules was referred to as having had a most important influence upon the increased mileage of cars. It was recommended that the secretary of the association should be empowered to decide doubtful cases of arbitration on the interchange rules, and further that a charge of $10 should be made before the entertainment of any case of arbitration before the Arbitration Committee, the cost to be paid by the road losing the case. The appointment of a commiitee to decide upon a safe limit of life for iron and steel axles, giving the limit of sizes, was recommended. As to stenciling of cars the speaker thought it important to stencil the lengths as well as the diameter of all axles upon the trucks and to place the capacity of the cars upon their sides. Also it was considered desirable that when cars exceed 12 feet in height at the eaves or 14 feet high, at any point above the top of the rail, the figures should be noted on the car. He urged the importance of closely adhering to the association's standards, pointing out the fact that the members of the association have labored for many years to perfect standards which are very generally used in car construction, but the question which now confronts us was, what can be done to make them more closely adhered to. He recommended that a rule be adopted at the convention that Master Car Builders' standards and their necessary attachments may be applied, when practicable, without marring cars or impairing their strength, and that their use should be considered as proper repairs in interchange.

During the past year the association had lost by death the following members: D. L. Barnes, Osgood Bradley, R. E. Marshall, Peter Smith, L. Lightner, Joel West and F. H. Soule. Their deaths deprived the association of some who have been among the organizers and wisest of its counsellers, and others, who though younger in years of membership had already taken prominent part in the organization, as well as in the various departments of railway work in which they were respectively engaged. In cherishing their memories the association was but renewing allegiance to the principles of the association, to which they were loyally devoted. In closing, words of appreciation of the excellent work of the committees for the year were offered.

The Secretary, Mr. J. W. Cloud, then presented his annual report, which showed a net increase of 28 in the membership, which stands now 440, including representative and associate members. The Treasurer, Mr. G. W. Demarest, reported all bills paid and a balance of $6,096.23 on hand. Mr. Mackenzie suggested the omission of the dues for the coming year in view of the amount of the surplus, but no action was taken on account of the statement from the Secretary that the Executive Committee had decided to use from the surplus to defray the expenses of the members of committees in their work for the next year.

Under the head of new business Mr. S. Higgins suggested the transmission of the resolution of the association passed last year with regard to the adoption of the metric system to the American Railway Association. This was ordered done. An invitation to the association to attend the Tennessee Centennial Exposition was then read.

TOPICAL DISCUSSIONS.

After several other items of new business were disposed of the convention took up the discussion of the questions propounded by members, the first of which was: Should brakebeams on four-wheel passenger car trucks be hung outside or between the wheels?

Mr. A. E. Mitchell opened the discussion by stating the advantages of inside hung brakes. If hung inside they did not interfere with the removal of wheels; they permitted of compact construction; this did not require the use of release springs and a further advantage was offered of giving less recoil of the trucks in stopping trains. Mr. Mitchell had four cars so equipped with 96 per cent. brake leverage, and stated that the gain in the stopping of trains with the arrangement was about 20 per cent. over the outside arrangement and the sliding of wheels was reduced.

Mr. Barr thought that inside hung brakes would increase the sliding of wheels. The experience of members seemed to be generally favorable to inside hung brakes. Mr. Apps, of the Canadian Pacific, reported entire satisfaction with inside hung brakes when 90 per cent. of braking power was employed.

Mr. J. N. Barr then presented the subject: Advantages and disadvantages of the system of mounting car wheels as suggested

to the New York R. R. Club by Mr. George Tatnall at the February, 1897, meeting of that club.

He did not find any bad results of frog impingement on straight track, and concluded that guard rails did not prevent impingement of frog points on straight track. He recommended a throat opening of 2½ inches on straight track. The guard rail was advantageous in preventing derailments but not impingements.

He asked: Why not use the present check gage for mounting wheels? The thickness of the flange would not need to be figured, and this gage might be used as a mounting gage without any trouble.

Mr. Mendenhall pointed out the importance of placing the standards and recommended practice of the association beyond the reach of criticism such as was offered by Mr. Tatnall's paper.

The next subject was: What is the best way to overcome injury to trucks and track due to salt-water drippings from refrigerator cars?

It was opened by Mr. S. Higgins, who stated that to the troubles previously experienced from this cause were added the corrosion of automatic signal bond wires. A sample pair of angle bars laid in 1890 showed that a single pair of splices, originally weighing 37 pounds, corroded to weigh only 29 pounds. Trucks had broken down on 15 refrigerator cars due to this cause on the Lehigh Valley Railroad. The proper solution of the problem seemed to be the use of ammonia in place of ice for refrigerating purposes.

Mr. Waitt urged the immediate use of tanks for catching the drips of these cars. By a vote on a motion by Mr. Lentz this subject was placed upon the list for report at the next convention.

The next topic. "Journal box lids. What reasons, if any, exist for or against the revising of our present standard in box lids?" was opened by Mr. R. H. Soule. The trouble was that of the wearing of the box by the lid requiring a new arrangement of the hinge. The spring also caused trouble by pressing the lid close to the top and leaving the fit a loose one at the bottom of the opening. He recommended the use of ground joints and an application of the spring to the center of the lid instead of at the top. Mr. Schroyer had been able to secure a dust-tight joint with a top-hinged lid by making it rabbeted along the sides. He used a light malleable iron lid.

Supervision of Standards.

The report of the Committee on Supervision of Standards was read by Mr. R. H. Soule, chairman.

Mr. Mendendall moved that the recommendations of the report be referred to the Executive Committee for the necessary action. Carried. No discussion.

Triple Valve Tests.

The chairman of the Committee on Triple Valve Tests reported that no triples had been submitted for tests during the year. No discussion.

Standard Wheel Gages.

Mr. Barr announced that the Committee on Standard Wheel and Gages had no recommendations to offer, and Mr. Potter stated that he was authorized to offer the use of a portion of track upon his road for train resistance tests to determine what is the best gage to use for wheels which are to run on a track gage of 4 feet 8½ inches.

The standing Committee on Brakeshoe Tests then announced that it had no report to offer, as there had not been a sufficient development on the subject to justify further tests.

Automatic Couplers.

The next subject was the report of the Committee on Automatic Couplers. The recommendation with regard to the change in the pocket strap was referred to letter ballot. Messrs. Rhodes, Barr and Lentz argued in favor of doing away with the lips on the ends of the straps.

SECOND DAY.

Automatic Couplers.

The session of Wednesday, the second day, opened with a continuation of the discussion of the report of the Committee on Automatic Couplers Vice-President C. A. Schroyer presiding. The action taken was to adopt the recommendations of the committee.

The report on Uncoupling Arrangements for M. C. B. Automatic Couplers was taken up. On motion by Mr. Bush it was ordered that the report be submitted for letter ballot for adoption as recommended practice.

Interchange Rules.

The revision of the interchange rules was then considered in connection with the report of the Arbitration Committee. The rules were read section by section. The early part of the discussion centered around the question of the responsibility for improper repairs. The first action was to adopt a recommendation to hold companies responsible only for improper repairs made by them, and this idea was inserted in the preface of the rules, this being the most important change which was made. The rule with regard to the owner's responsibility for worn flanges was modified as to dimensions. The principal participants in the debate upon the rules were Messrs. Rhodes, Chamberlain, Sanderson, Mendenhall, Bush, Waitt and Garstang. A number of changes were made in the rules and these were chiefly along the line of the report of the Arbitration Committee. Mr. Rhodes made a motion to the effect that to section 16 of rule 4 the following should be added: "Delivering companies shall not be held responsible for any wrong repairs to draft rigging and axles or wrong repairs to owner's defects not made by them."

Mr. Barr made some very pointed remarks about the use of repair cards, and was almost of the opinion that it would be wise to take summary measures with inspectors who did not make proper use of them. While discussing the revision of the rules the chairman read a communication from Mr. G. W. Booth, General Auditor of the B. & O. R. R., stating that he and Mr. L. F. Sullivan, Auditor of the C. & O. R. R., had been appointed by the Railway Accounting Officer's Association to confer with the M. C. B. Association with regard to the advisability of making changes in the rules governing methods for billing for repairs to foreign cars. The meeting was addressed by Mr. Booth, who expressed a strong desire that the heartiest co-operation should be had between the accounting officers and the car department officers. The absurdity of conducting expensive correspondence in connection with very trivial items was shown and the speaker dwelt upon the inconvenience of having bills referred to their authors for corrections after they had passed through the hands of the car department officers. Mr. Garstang moved the appointment of a committee to confer with Messrs. Booth and Sullivan upon this subject, and the following members were named for this committee: Messrs. Garstang, Haywood and Mitchell. The committee recommended that the last paragraph of rule 5, section 12, on page 5 of the report of the Arbitration Committee should be stricken out and the following substituted therefor:

"Bills shall not be rendered for amounts less than 25 cents in aggregate, but charges for items less than 25 cents may be held until they amount to that sum, provided said aggregate is rendered within 60 days; no bill shall be returned for correction on account of error for less than 25 cents, but request shall be made for credits and adjustment in subsequent month.

"All offices rendering bills should consolidate all charges against any one company into one monthly bill.

"Your committee further recommends that the Master Car Builders' Association appoint a standing committee to consider with the Committee of the Accounting Officers' Association questions relative to bills and accounting, such committee to report at each annual convention."

This report was adopted and Messrs. Hennessey, Sanderson and Bush were appointed as a committee to report recommendations in regard to the revision of prices for repairs to foreign cars.

Uncoupling Arrangements for M. C. B. Couplers.

The next subject introduced was the report of the committee entitled Uncoupling Arrangements for the M. C. B. Automatic Couplers. This will be published in abstract in a later issue of this journal. Upon a motion by Mr. Bush, the recommendations contained in the report were ordered to be submitted to letter ballot.

The following gentlemen were then proposed for associate membership: Messrs. Walter D. Crosman and Edward A. Phillips.

NOMINATION OF OFFICERS.

The secretary announced that the nominating committee had submitted the following report for the officers for the year 1897–98:

President, S. A. Crone, N. Y. C. & H. R. R. R., New York.

First Vice-President, E. D. Bronner, Mich. Cent., Detroit, Mich.

Second Vice-President, C. A. Schroyer, C. & N. W. Ry., Chicago.

Third Vice-President, J. T. Chamberlain, B. & M. R. R., Boston.

Treasurer, G. W. Demarest, Northern Central R. R., Baltimore.

Three members of the Executive Committee to replace outgoing members were Messrs. W. S. Morris, Samuel Higgins and C. M. Mendenhall.

The meeting then adjourned until Thursday morning.

THIRD DAY.

Interchange Rules.

The special committee appointed to revise the prices given in the interchange rules was the first to report. The suggestion that a standing committee on prices be appointed was offered to the association, and the prices were revised to bring them up to date. The report of the committee was briefly discussed, the question of territorial arrangements for prices being brought up by Mr. A. L. Humphrey, of the Colorado Midland Railway. Mr. Humphrey suggested that in order to secure fairness to Western lines 10 per cent. should be added to charges on repairs made west of the 105th meridian. Messrs. Small, Fowler and Childs supported Mr. Humphrey, while Messrs. Barr, W. H. Lewis, G. A. Marden and J. T. Chamberlain thought that the prices should not be increased for the West. Mr. Barr thought the question impossible for solution on the basis of equity. He considered the complications of adjustment a greater difficulty and more objectionable than the present injustices which applied in many sections other than in the West. The report of the special committee provided that this question should be investigated by the standing committee to be appointed. Mr. Humphrey put his suggestion in the form of a motion, which was voted down.

Mounting Wheels.

A report on the subject of mounting wheels was offered by Mr. Barr. The essence of this was the recommendation of the use of the standard check gage for mounting wheels. It was referred to letter ballot for adoption.

Interchange Rules.

Mr. Potter reported for the committee appointed to suggest a scheme for the presentation of cases to the arbitration committee concerning Rule II. The cases were to be presented to the committee in abstract in the form of briefs signed by the parties in dispute. The report was adopted. The object was to relieve the committee of unnecessary labor, and to settle as many cases as possible without bringing them before the committee.

Upon motion by Mr. Waitt, the interchange rules as a whole were adopted as amended, and upon a subsequent motion the rulings of the Arbitration Committee were approved.

Loading Long Material.

Mr. Leeds presented the report of the committee on the subject: Loading Logs, Bark and Long Structural Material. Upon a motion by Mr. Waitt, the recommendations of the committee were referred to letter ballot for adoption as recommended practice for a year's experience.

Trains Parting.

Mr. A. M. Waitt read the report of the Committee on Trains Parting. In discussing it Mr. Simons urged that a new form of uncoupling attachments connected in a way to render them less liable to damage should be used, and he was supported by Mr. Waitt, who believed that attachments might be made directly to the couplers. Mr. Rhodes thought that the use of buffer blocks would greatly decrease the expense of repairs to draft rigging. The importance of these blocks should not be lost to sight. He found that solid buffers were entirely satisfactory in use on wooden cars, good results having been found from a recent application of them to 1,000 cars. Secretary Cloud called attention to the fact that the recommended practice of the association approved of their use. The report of the committee was accepted and the committee continued to enable them to put their own recommendations into practice, as the motion was expressed by Mr. Leeds.

Passenger Car Pedestal and Journal Box.

Mr. Geo. W. West presented the report of the Committee on Passenger Car Pedestal and Journal Box for Journal 4¼ by 8 inches. The report was referred to the Committee on Standards and was afterward adopted upon the recommendation of that committee.

Specifications for Cast-Iron Wheels.

The next subject was the report entitled: Specifications and Guarantee for Cast-Iron Wheels, read by Mr. J. N. Barr. The discussion consisted chiefly of questions and explanations with regard to the report. The thermal tests were indorsed by Mr. Barr as the best method of testing wheels. Mr. Atterbury moved that in the provisions of the report with regard to physical tests the thermal tests should be made in connection with the drop test. This speaker presented some interesting figures which tended to show the importance and value of the tests in the improvement of the quality of wheels. Mr. Atterbury's motion was carried.

TOPICAL DISCUSSIONS.

At noon the topical discussions were introduced, the first being: What is the exact meaning of the latter part of Rule 5, Section 8, in connection with replacement of wheels and axles? No discussion. The next subject was: "Would it be advantageous to adopt standard coil springs for freight car trucks?" This was introduced by Mr. Sanderson, who answered the question expressed in the topic in the affirmative. Mr. Waitt moved that the subject be referred to the Committee on Subjects for treatment next year. Mr. Sanderson's presentation of the matter was so complete and satisfactory that no discussion was offered.

Mr. W. C. Appleyard, of the N. Y., N. H & H. R. R., introduced the next subject: Copper sheathing for passenger cars; how is it applied and what are its advantages? The experiment recently carried out by the speaker was described, in which a passenger car was sheathed with sheet copper. The entire exterior of the car was covered with No. 28 copper, but No. 30 was thought to be more advantageous. The copper was oxydized after application. The appearance after a half year's use was as good as when new. Details of making the joints in the plating were described. The color was almost exactly that of the Pullman cars. Mr. Appleyard exhibited a sample showing the method of application. The cost of the copper sheathing was about $50 more than that of painting, and the saving expected is from the shop space and cost of repainting. The work could be done in the erecting shop, not requiring a special building for the purpose. Mr. Mitchell raised the question as to what effect the copper sheathing would have on the durability of the wooden sheathing. He thought that moisture might collect between the copper and the wood to the deterioration of the latter. Mr. Appleyard said that no trouble had been found with regard to expension and contraction, and that time would show the importance of this question. Great interest was shown in this subject.

Mr. F. W. Brazier introduced the topic: Is the retention of the dummy coupling desirable on freight equipment?" The speaker did not believe in either hanging the hose up in the customary way or in allowing it to hang down without protection

from dust. He thought the use of an automatic closing device for the hose coupling desirable. Mr. Rhodes reported entirely satisfactory experience with the practice of allowing the hose to hang down. He approved of using a closing device. Mr. Schroyer was not satisfied to let the hose hang down, owing to the accumulation of dust. He also approved automatic closing devices and thought the one formerly used by the Westinghouse Company the best that he had seen. Mr. S. Higgins found that he could get good results with the dummy couplings, the use of which he had not abandoned.

Thermal Tests for Wheels.

Mr. Potter gave some interesting comments upon the thermal testing of wheels, which will be published in full in a future issue of this journal. There was no discussion of his remarks.

Testing Laboratories.

Mr. Schroyer read a brief paper to introduce this subject. He strongly endorsed the plan of establishing such laboratories and made a point of the fact that steel was now more generally used than formerly in car construction. He recommended buying material on specifications, subject as far as possible to physical tests, and had found much inferior material in that which had been offered to his road. The establishment of testing bureaus among the roads was suggested. The apparatus was not very expensive and a man with a technical education was not absolutely required for the handling of such work. Mr. Sanderson also mentioned testing bureaus supported by several roads jointly. Such a plan was thought to have advantages over the present practice of separate testing departments on the various roads, Mr. Rhodes gave strong support to laboratory testing and Mr. R. H. Johnson took the old-time view of the laboratory testing question, because tests, which should exactly resemble the shocks and stresses of service, could not be made upon machines.

Air-Brake and Signal Instructions.

This report was read by Mr. E. W. Grieves and it was referred to the committee again for further report next year. Some inconsistencies were found in it. After this the session adjourned.

FOURTH DAY.

Freight Car Buffers.

The session of Friday was opened at 9:30 a. m. with the reading of the report entitled, Improved Freight Car Buffers, by Mr. F. W. Brazier. The discussion was opened by Mr. Rhodes, who argued in favor of the use of solid buffers placed against the end sills, this arrangement being elastic enough and very nearly as effective as the spring buffers which were closed solid impact at very low speeds. Mr. Sanderson supported the previous speaker's opinion. Mr. Waitt thought that efforts should be made to reduce shocks to cars as far as possible. The present devices might not be strong enough, but the idea of spring buffers was good and the buffers should be applied opposite the sills whereby the stresses could be transmitted along the car frame. Mr. Waitt moved that the recommended practice concerning the details of buffer blocks should be submitted to letter ballot for adoption as a standard of the association. Carried.

Box-Car Doors.

The report entitled Box-Car Side and End Doors was the next subject. It was read by Mr. J. J. Hennessey. After a brief discussion Mr. R. H. Soule moved the adoption of the recommendations of the committee as recommended practice of the association.

Arch Bars and Column Bolts.

The next subject was the report entitled Arch Bars and Column Bolts of Diamond Trucks, which was read by Mr. J. E. Simons. There was very little discussion, and upon motion by Mr. Waitt, the recommendations of this committee were also referred to letter ballot for recommended practice.

Steel Car Frames.

The last of the reports of the technical committees was the "Joint report of five members appointed to present individual designs for steel underframing for freight cars," read by Secretary Cloud. The discussion was opened by Mr. Sanderson, who called special attention to the summary of the dimensions desired by the members for standard construction as expressed in the diagram presented in the report. Mr. Waitt moved the reference of the recommendation of the committee as to standard dimensions for cars to letter ballot as recommended practice for one year. Carried.

Mr. Waitt then made another motion to the effect that a new committee be appointed to consider the various designs submitted and recommend a design. Messrs. Barr, Sanderson and Joughins took part in the discussion, which consisted principally in explaining the designs submitted.

TOPICAL DISCUSSIONS.

Topical discussions were then taken up, the first being entitled "Is there any advantage in the use of M. C. B. Air-Brake Defect Cards?" which was presented by Mr. Thos. Fildes. These cards were important because they gave information to the trainmen as to the condition of the air-brakes upon cars and without them much trouble and delay was occasioned by the absence of definite information as to what was wrong when brakes were cut out. The cards were considered as very valuable and several members strongly advocated their employment.

"Is it a safe and advisable practice to splice air-brake hose, and should such hose be condemned in interchange?" was next introduced by Mr. Rhodes, who stated that for a cost of 7½ cents a hose could be spliced as against 75 cents for a new hose. He showed that this amounted to a saving of $1,800 per year for one of the shops on the C., B. & Q. R. R., an item worthy of consideration. If good material and workmanship were used there was no objection to the use of spliced hose and it was economical and permitted the saving of hose which was but slightly damaged. The association by vote expressed its opinion to the effect that the proper splicing of air-brake hose was a safe practice.

In the discussion of the topic with regard to the advantages of adopting an M. C. B. coupler defect card, Mr. Rhodes advocated the use of such cards.

The subject of specifications for air hose was introduced by Mr. Waitt, who gave an interesting exhibition of samples of air hose, showing the great differences in quality of this material, which is in ordinary use. He urged the great importance of improving the quality of hose. Mr. Barr agreed with Mr. Waitt in believing that it would be safe to use two-ply hose. He did not believe in specifying high pressure tests or in guarantees. Mr. H. M. Carson recommended elasticity tests of hose, that hose being best the rubber of which would show no permanent set after stretching.

After brief discussions on the remaining questions which had been propounded, and action referring the question of a uniform system for locating defects on repair cards to the committee on subjects, the report of the committee on subjects was presented and referred to the executive committee. The usual resolutions in recognition of the courtesies and privileges enjoyed by the members of the association were then presented and adopted.

Instead of nominating places for holding the next convention, it was decided to take this up in connection with the letter ballots to be sent out by the Secretary.

The next business was the election of officers, and by vote the Secretary was instructed to cast ballots for the gentlemen mentioned in the report of the nominating committee already given.

The convention adjourned at 12:10 p. m.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION—PROCEEDINGS OF THE THIRTIETH ANNUAL CONVENTION.

The thirtieth annual convention of the American Railway Master Mechanics' Association was opened at Old Point Comfort, Va., June 15, 1897, President R. H. Soule in the chair. After the opening prayer by Rev. W. F. Sheppard, the address of welcome was given by Col. H. C. Hasbrouck, who in the course of his remarks explained the purpose of the artillery school at Fortress Monroe, stating that one-fourth of the whole artillery force of the United States army was stationed at that post. He gave a cordial welcome to the association.

The presidential address was delivered by Mr. R. H. Soule, who spoke first of the appropriateness of holding the convention of a national organization upon national property. The membership of the association at the first meeting was 41, and it had grown to be the largest of the railroad technical organizations. The subjects of the early conventions were briefly reviewed as indicating the rapid advances made in the designs of locomotives. Most of the work in the improvement in this line had come within the 30 years of the life of the organization. Since the last meeting much progress had been made. Higher pressures were now the rule even with simple engines, 180 pounds being now very common. Large driving wheels, the use of piston valves, the reduction of weights of reciprocating parts, the use of larger cylinders, constituted marked steps in advance. Reduced lead and the use of inside clearance were also mentioned along with the increasing use of cast steel in locomotive construction. Boiler-feeding devices had been greatly improved. Heavier locomotives were approved even if the track required strengthening. The general adoption of the tonnage system of rating trains had been a feature of the year. The compound locomotive was still in the balance, but it had doubtless gained friends during the year, and progress had been made in the locomotive from a commercial standpoint. The adoption of the Master Mechanics' decimal gage by the American Steel Manufacturing Association and the American Society of Mechanical Engineers was a pleasing endorsement of the work of the association. Mr. Soule saw a good result from the "hard times" in that the work of the members were improved through the necessity for frequently asking the question: "Will it pay?" In this connection the railway clubs had contributed valuable assistance, with good effect, in the discussion of questions of economical operation. The important suggestion was made that the two annual conventions of the Master Mechanics and the Master Car Builders' Associations might be held in one and the same week, saving valuable time of the members.

Among the suggestions for work for the next year was that a committee should be appointed to investigate and report upon the subject of the application of electricity to tractive purposes.

The minutes of the previous meeting were adopted as printed and the report of the Secretary was presented. At the last meeting the membership was as follows: Active, 615; honorary, 24; associate, 18; total, 657. This year the figures stood: Active, 577; honorary, 26; associate, 17; total, 620.

The amount of cash on hand, as given in the report of the Treasurer, was $1,659.01, all bills having been paid. This report, as well as that of the Secretary, was referred to an Auditing Committee composed of Messrs. Henderson, Lawes and Sinclair. The report showed the accounts to be correct.

Under the head of unfinished business the proposed amendment to the constitution which provides for a Third Vice-President was taken up and carried. The regulations with regard to the association scholarship as provided by the constitution were amended to the effect that in case the scholarships were not taken up by the sons of master mechanics at the time of the June examinations they should be open to the sons of railroad employees or of deceased employees. It was provided that employees or sons of employees in the mechanical departments should have the preference over others.

Mr. E. C. Bates was elected to associate membership, and Messrs. C. H. Prescott and W. H. Stearns were elected honorary members of the association.

A communication was read from Mr. Henry Schlacks, Superintendent of Motive Power of the Denver & Rio Grande Railroad, taking exceptions to the remarks which were made at the convention of last year by Mr. Angus Sinclair with regard to burned crown sheets on that road. This called forth an explanation by Mr. Sinclair of the remarks referred to, which were not intended as a reflection upon the road mentioned or its officers, and the remarks were stated to have been made upon what was believed to be good authority. This was accepted by the convention as an acknowledgement of error.

In accordance with the suggestion of the President, Mr. W. H. Lewis then presented a resolution to the effect that the executive committee should be authorized to arrange the days and the hours for the next convention with a view of consolidating the meetings of the Master Car Builders' and the Master Mechanics' Association into a single week, the opening exercises to be consolidated also. A conference committee of 11 members including the members of the Executive Committee was provided for, to take up the subject with the Master Car Builders' Association by a joint meeting with 11 members of that association. This was carried.

Mr. Wm. Forsyth moved that the executive committee should be instructed to invite a railroad president, manager or chief engineer to present an address to the association at the next convention, this being in accordance with a suggestion offered by Mr. M. N. Forney in an article published in the June issue of the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, the details of time and place for the address to be left with the Executive Committee.

TOPICAL DISCUSSIONS.

Piston Rods.—Mr. G. R. Henderson introduced the subject which was important on account of the breakage of piston rods and their weight also constituted a source of trouble. The only way to lighten them was to make them hollow and a number of experiments had been tried with tubular rods, which included tensile and compressive tests. He exhibited a drawing of the articulated crosshead, which was illustrated in the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL of June, 1897. This was designed for the purpose of reducing the breakage of piston rods. Mr. Vauclain stated that the saving of weight of a rod when hollow was about 50 per cent., the cost not being greater than the solid rods. Mr. Platt described practice in the use of hollow piston rods by Messrs. Thorneycroft in torpedo boat construction. The engines were high speed and ranged up to 3,000 horse-power. The practice was very satisfactory. Cold-drawn tubing was recommended. Mr. J. D. Barnett, of the Grand Trunk, had used tire steel for piston rods for three years with satisfactory results and was not afraid to use high carbon steel for this purpose.

Mr. R. Quayle gave a good report upon his experience with nickel steel. The rods were of small diameter, with enlarged ends, which distributed the flexure over the entire length of the rod, and no failures were had in two or three years experience. Mr. A. W. Gibbs strongly advocated enlarging the ends of rods to increase their strength. He recommended stiff high carbon steel as being better to withstand shocks. Nickel steel had the advantage of cracking and giving warning before breaking. This material did not weld, and it was likely to contain seams, which, however, did not interfere with its satisfactory use for piston rods. He considered it the best material for piston rods.

Compound or Simple Locomotives.—Mr. W. S. Morris gave the record of a Richmond compound, covering four years of service, as compared with 10 simple engines running in the same work. Repairs cost about one per cent. more for the compound than for the simple engines. The fuel consumed with 18 per cent. increased mileage was about six per cent. less for the compound. It was more economical in the use of oil and ran 19.2 per cent. more miles per ton of coal. Six compounds compared with the same number of simple engines for last year were more economical than the simple engines. Mr. Wm. Garstang supported Mr. Morris in regard to the saving in fuel by use of the compound, his experience being had with the Richmond Locomotive Works' type of compound, and stated that he had found the advantage to be about 17 per cent. Mr. George Gibbs gave comparisons between 11 simple engines and 11 Vauclain compounds, which showed the compounds to average 20.3 per cent. in saving over the simple engines, all of the compounds being cheaper than the best simple engines in the use of fuel. Mr. R. Atkinson's experience had been very favorable to compounds. He had been able to save about $2,000 per year with each compound over the simple engines with coal costing about $3.70 per ton. Mr. Quayle had found great differences between two cylinder compounds with various ratios between the areas of the cylinders. He had found a ratio of 2½ to 1 to be the best as to economy. Mr. Herr added to the testimony favoring the compound. All of the speak-

ers reported in favor of that type, showing that in their opinions the compound had come to stay.

COMMITTEE REPORTS.

Exhaust Nozzle and Steam Passages.—This report was presented last year, and the subject was continued to obtain results from a year's experience with the front end arrangements as recommended by the committee. Mr. Wm. McIntosh and Mr. T. J. Hennessy reported favorably upon the practice recommended by the committee, and the session adjourned before finishing the discussion.

SECOND DAY.

The first business of this session was the admission of Mr. E. F. Moore, Mechanical Engineer of the Railroad Commission of the State of Michigan, to associate membership. The Auditing Committee then reported the accounts of the Treasurer and Secretary to be correct. The reports were then resumed.

Exhaust Nozzles.

Mr. E. M. Herr, of the Northern Pacific, reported upon his experience with the recommendations of the committee on exhaust nozzles and steam passages. He gave evidence which was favorable to the arrangements recommended by the committee. Mr. R. Atkinson, Canadian Pacific, described his experience, which had shown him that he could save coal and avoid throwing sparks from the stack, by using the recommended arrangements, though he had not been able to enlarge the exhaust nozzles to any great extent. The steaming of the engines was improved and the fires were thinner, being only about one-half as thick as formerly and light firing was required. Mr. Cockfield, C. & N. W. Railway, was the next speaker. He had been able to decrease the cost of hauling trains about 16 per cent., stated in terms of pounds of coal per car-mile, by the use of the new front end arrangements.

The report by Mr. P. H. Peck, C. & W. I. Railroad, was also favorable to the new plan, and Mr. J. E. Sague, of the Schenectady Locomotive Works, spoke from the standpoint of the locomotive builders. The recommendations had been carried out in the building of locomotives, and from reports received he was led to believe that the recommendations constituted a marked improvement. Mr. Wm. Forsyth pointed out the importance of making the choke of the nozzle large enough for the largest tip which was to be used. The relation between the choke and the exit of the pipe was the really important feature of the recommendation and the choke should not be smaller than the exit. In the remarks of to-day the favorable reports of the previous session were generally supported, yet several members failed to find the arrangements economical. Professor Goss remarked that it was not necessary to the justification of the report that improved economy should be found in the use of the arrangements. To design draft appliances with certainty of obtaining the desired results in operation was one of the purposes of the investigation.

Counterbalancing Locomotives.

This subject was introduced by Mr. Herr. The difficulty in getting sufficient counterbalance in the small driving wheels of some consolidation engines was referred to by Mr. Henderson He believed that there was no reason why the weights should be distributed equally among the wheels, and was supported by Mr. Leeds, who would put the excess in the main and the intermediate wheels and balance only the revolving weights in the forward and rear wheels of consolidation engines. Mr. Wm. Forsyth took up the relations between the counterbalance and the section of the rails, quoting interesting experiments conducted on the Boston & Albany, the C. B. & Q. and the Pennsylvania Railroads by Mr. Howard, of the Watertown arsenal, and offered the suggestion that the civil engineering side of the question should be considered with special reference to the maximum allowable stresses in the rails.

Truck Swing Hangers.

This report was read by Mr. Wm. Garstang, and owing to the completeness of the report and to delays in the work of the session there was no discussion.

Locomotive Grates.

Prof. H. Wade Hibbard read this report by abstract.

Mr. H. A. Gillis reported satisfactory experience with the alternating use of anthracite and bituminous coal on the same engine one being used for one direction and the other for the opposite direction. It was not done from choice, but could be done if necessary without trouble.

The Apprentice Boy.

The subject was brought before the meeting by Mr. W. F. Bradley, who introduced it by a few remarks, in which comment was offered upon the tendency for operating officers to give more attention than do mechanical officers to the questions affecting the education and preparation of employees for their duties.

Mr. Robinson read the recommendation of the committee to the effect that a standing committee be appointed with very wide powers for the purpose of negotiating with institutions of learning with a view of experimenting in the line of university extension. In the discussion the trade portion of an apprentices' education was given a more important place than the academic work. Mr. Vauclain referred to the difficulties of interference between the care of old employees and the admission of apprentices. He approved of taking apprentices, educating them and then discharging them unless they were needed in the working forces. His plan would improve the boys in that the protection of the shops would be removed at the completion of the instruction. It would also make rooms for others. He believed that shops should be opened all over the country as manual training schools on such a basis as he described. Mr. Gillis supported the plan of turning apprentices away for experience after finishing their courses. Mr. Morris then moved that the recommendation of the committee be adopted to the effect that a standing committee be appointed to report upon the subject of the "Apprentice Boy" without a statement of the limitation of the powers of the committee. Carried.

TOPICAL DISCUSSIONS.

Cylinder Clearance.—The economy of large cylinder clearance was in question. Mr. Angus Sinclair took the position that large clearances led to a great waste of steam. Foreign practice was an improvement upon ours, owing to shorter steam passages, and this was believed to be the only advantage possessed by European over American locomotives in leading to more economical operation. Mr. Herr believed that excessive clearance was not conducive to economy; but the better performance of European locomotives was thought to be due to better qualities of coal and to the fact that foreign trains were lighter than ours.

Piston and Slide Valves.—Mr. Wm. Forsyth referred to the fact that piston valves were more generally used in compound than in simple locomotive practice, though he could see no satisfactory reason for this.

Piston valves were difficult to set, and it was important that the ports should be square and that the steam should be allowed free admission into the ports. He gave good accounts of the wearing of the valves, and stated that the rings should be as deep as could be sprung on. These valves gave little friction, and were believed to have advantages over slide valves, especially for high pressure. The balancing made it possible to handle the reverse levers easily, which was very important. Mr. Quereau believed the Allen port to be a valuable adjunct to a valve, and one objection to the piston valve was that this port cannot be used with this type.

Water on Locomotive Bearings.—Mr. A. E. Mitchell had found it possible to use water on locomotive bearings with success. Mr. Herr objected to the statement that water was a lubricant, and believed that water should be used only in cases of emergency. Mr. West had good results by using water in circulation over the driving axles of wide firebox locomotives, the central part of the axles being cooled thereby.

Manual vs. Automatic Control of Compound Feature of Compound Locomotives.—This subject was introduced by President Soule, whose experience had been with the Vauclain type, which had manual control, and his preference was for that form of control. Mr. Morris approved of an automatic control which could be operated manually if necessary. Mr. Herr stated that the only compound locomotives which had given him any trouble

were those which could not be controlled manually when desired. This view was supported by Messrs. Mitchell, Gibbs and Quereau. Mr. Henderson argued that inasmuch as manual control was desirable, the superfluous complication of automatic controlling devices should be avoided.

Irregular Wear of Cylinders.—Mr. W. A. Brown referred to the fact that the top walls of cylinders frequently wore more than the lower ones. This was believed to be due to inequalities in cylinder material. Mr. Herr, however, thought that such wear was due to poor fitting of the bull ring, while Mr. G. W. West attributed it to the influence of the crosshead and piston rod. The discussion was very brief.

Lead for Locomotives.—This was opened by a communication by Mr. E. L. Coster, who enumerated the well-known advantages of reduced lead. He suggested the appointment of a committee to report upon the subject to the association with recommendations for practice with different valves.

Broken Staybolts.—Mr. T. A. Lawes read a brief written discussion of this subject, which contained a description of tests on the breaking of bolts by drilling into the bolts. The hammer test was shown to be a failure as to detecting partially broken staybolts. Either hollow stays should be used or the staybolts should be drilled. The extra cost in his estimation was not important.

Mr. MacKenzie preferred giving greater water space to the drilling of staybolts. Mr. McIntosh believed in drilling the bolts and practising close inspection. Mr. Vauclain approved of the drilling of staybolts when new and also would reduce the diameter of staybolts between the sheets.

After the discussion of this subject the committee reports were again taken up.

Best Metal for Cylinders.

The conclusions of this report were read by the Secretary, and Mr. G. R. Henderson opened the discussion with remarks upon the practice of the Norfolk & Western Railroad in the use of steel mixtures in cylinder castings. The strength and wearing qualities of the mixtures were favorable. Mr. McIntosh suggested the use of cast-steel cylinders with cast-iron bushings, the advantages being great strength combined with good wearing qualities.

Mr. Leeds questioned whether steel and iron could be satisfactorily mixed before casting. Mr. S. M. Vauclain, of the Baldwin Locomotive Works, read a brief paper upon the subject of the cast-iron cylinder mixtures used at those works.

Grate and Heating Surfaces and Cylinder Volumes.

This was read by Mr. G. R. Henderson. It was the most exhaustive and ingenious report of the convention and excited much favorable comment. It involved great labor and research on the part of the committee and was unquestionably appreciated. Mr. Herr opened the discussion by calling attention to the report at the first presentation of a method of getting at the subject of the relations between grates, heating surface and cylinder dimensions. Professor Goss complimented the report for its ingenious analysis. The discussion was very brief, probably on account of the fact that a large amount of study was required in order to prepare for handling it intelligently.

Boiler Jackets.

The discussion on this subject was also very brief, and special attention was called to the fact that the Master Mechanics' standard gages were not used by those who replied to the questions asked by the committee. This sort of thing justified the criticisms frequently offered to the association to the effect that standards were adopted only to be disregarded by the members. Upon vote by the association the sizes of the sheets mentioned in the report were ordered translated into the terms of the standard gage, and also references to this part of the discussion were ordered expunged from the records of the meeting. The session then adjourned.

THIRD DAY.

Piece-Work in Locomotive Shops.

Mr. Pulaski Leeds, chairman of the committee, presented this subject with a brief explanation of the conclusions of the committee. Mr. McConnell opened the discussion with a statement to the effect that he had never favored piece-work systems in railroad shops. It was, however, very successful in contract shops wherein the work consisted largely of duplication. He did not consider the conditions in railroad shops as suitable for such systems. Mr. Wm. Swanston's remarks had to do chiefly with wages, and he believed it to be important that men should be assured that their wages should not be reduced under piece work system. He deprecated the practice of comparing prices between various shops where conditions must necessarily be different. Mr. Rufus Hill heartily endorsed the piece-work system. Its influence upon the men was good, as it encourages them to their best efforts, and altogether he had found it successful. He urged good management of the system, and agreed with Mr. Swanston with regard to comparing prices. Mr. L. R. Brown (P. R. R.) placed great stress upon showing the men that they have the opportunity to increase their wages by piece-work rates, and the earnings under that system were increased upon the road with which he was connected. Fairness to the men and a complete understanding between men and officers was important. Taylor's system was endorsed and its underlying principles were considered in the system used at the Juniata shops. It was thought necessary to apply the system to helpers as well as to machinists and these share in the results of their extra efforts. The apprentices did not share in such increase because of the extra care required from the foreman in their education. Mr. H. A. Gillis spoke of the necessity of most careful attention to the establishment of prices. In his system the apprentices did not share in the increased production, but the machinist obtained the benefit of the apprentice's efforts, which tended to cause the machinist to develop and instruct the apprentice to the best of his ability. This improved the instruction and was fair to the boys. He did not approve of applying piece-work in boiler shops, where no chances should be taken in regard to the quality of work. It was also difficult to apply it to erecting work. Mr. Herr brought up the question as to whether piece-work was necessarily poor work. Mr. Brown replied to the effect that in piece-work it was necessary to watch the work rather than the man. For this reason flue and riveting work were placed upon the day-work schedule. There were portions of locomotive work which could not be satisfactorily handled under the present piece-work system. This system seemed to imply to the men the rule that as much work as possible should be done in the shortest possible time. This was not to be considered as dishonesty, but was due to the natural failings of men. There were, however, many items which brought better results under piece than under day-work. Mr. Rufus Hill had been successful with piece-work in the boiler shop by the use of penalties. In the discussion considerable weight was placed on the inferiority of work under piece-work systems, several doubters of the value of the system having made their objections known. In spite of this, however, it was clearly shown that careful administration of the system made it desirable in a great many processes, but careful inspection was very necessary. Mr. Deems expressed his opinion of piece-work as being a means of taking up the lost motion between jobs.

Motors, Steam, Air and Electric.

Mr. J. H. McConnell presented a few of the chief features of the report and gave some information, not contained in the report, with regard to the cost and operation of electrical apparatus. In the discussion cautions were given against using air-hoists and similar appliances where the work could be better done by hand. Reheating was mentioned as an adjunct worthy of attention and one speaker strongly advocated a combination of pneumatic and hydraulic systems for press work owing to the trouble from the elasticity of the air. Mr. Geo. Gibbs commented upon the comparison between air and electric tools. Electricity had not been successfully applied to drilling, but this was probably due to lack of attention to the subject by men who were familiar with the requirements for such work. This was a field worthy of investigation. He mildly criticised the report because it did not contain more comparisons between the different motors, but was rather a report upon labor-saving appliances.

Air Brake and Signal Instructions.

This was a joint report between the two associations and it was explained that the subject was continued by the Master Car Builders' Association for perfecting the report for presentation next year. The Master Mechanics' Committee was likewise continued.

Mr. P. H. Brangs then read a brief paper upon the subject of electric locomotives as applied to steam railroads. It contained suggestions with reference to the possibility of the use of electricity for the purpose of meeting the competition of electric street car lines and advocated the equipment of several tracks of the suburban lines of trunk railroads with electricity. By vote it was ordered that the paper be published in the proceedings and that the discussion thereon be held at the next convention.

The closing subject was the report of the committee on subjects for the 1898 convention. The report of the committee on resolutions was then adopted.

Messrs. C. H. Quereau, W. H. Thomas and Philip Wallace were appointed as a committee on the assignment of members upon committees for the 1898 convention.

The election of officers resulted as follows: President, Pulaski Leeds; First Vice-President, Robert Quayle; Second Vice-President, J. H. McConnell; Third Vice-President, W. S. Morris; Treasurer, J. N. Barr.

Topical Discussion.

The last subject, "Research Laboratory Under Control of American Railway Master Mechanics' Association," was introduced by Prof. Goss. It was briefly discussed with regard to a possible plan for adoption. It was not a part of the scheme that the larger roads should abandon their laboratories. Each road would pay for what work it required to be done, and the work would be confined chiefly to routine matters.

The expression of opinion with regard to the best place for holding the next convention included Niagara Falls, Denver and Saratoga, but no vote was taken.

The convention adjourned at12:20 p. m.

A Locomotive with Auxiliary Gear.

The Bavarian State Railway has recently received a lot of 12 new compound locomotives from Messrs. Krauss. & Company, of Munich and Linz, and one of them is of the peculiar design shown in the accompanying illustration, which is reproduced from *Engineering*. The owners of this locomotive do not appear to have absolute confidence in the design, since they specified that the arrangement should be so made as to render conversion into the ordinary type easy in case the auxiliary gear should t o prove to be satisfactory. The object sought was to combine the chief advantages of uncoupled wheels with the greater tractive force which four coupled engines afford in starting and in mounting grades. It was desired to secure a more perfect adaptability of the engine to the various requirements concerning speed and power during ordinary working. The advantage possessed by very large cylinders in giving great power at slow speeds was sought by a means which was expected to avoid the disadvantages of large cylinders at high speeds. The design provides adjustability of cylinder power to suit the needs by using a pair of cylinders working a single pair of large driving wheels, and adding an auxiliary engine of another pair of cylinders, below the first, working a pair of small wheels immediately in the rear of the rear truck wheels. This engine was put into service in December, 1895, and has been at work ever since with the exception of the time when it was at the Nurnberg exposition. The following is taken from the description of the engine given by our contemporary referred to:

The main pair of cylinders drive the 73.2-inch wheels. The diameter of the right-hand high-pressure cylinder is 15.16 inches and that of the left hand, or low pressure, is 24.01 inches.

The stroke in both cases is 24 inches. The cylinders are inclined 6 in 100, because the auxiliary cylinders had to be placed underneath, not to interfere with the engine profile. The valve chests, which are fitted with American balance slide valves, also lie inclined, in both the longitudinal and transverse directions. The valve gear is of the Heusinger-Walschaert type. The cut-offs are the same on both sides, while the cylinder ratio is 1: 2.51.

The receiver pipe passes through the smokebox, and bears above a safety valve loaded to 5.5 atmospheres, and in front a Ricour air suction valve, as shown. The starting gear consists of a Lindner cock, which is connected with the reversing rod, and at full gear allows the steam to pass from the boiler to the receiver, and of a Krauss interruption slide, which, fixed outside the high-pressure cylinder and worked from the right-hand link, prevents the passing of steam at those positions of the crank when the pressure in the receiver would only impede the starting.

This auxiliary engine is intended to insure a reliable and powerful start. It is entirely independent of the main engine and is fitted with two equal-sized cylinders. It is not in use except when a heavy pull is needed, that is, in starting and on steep hills. Under ordinary conditions the wheels of the auxiliary engine are kept off the rails and remain stationary. The wheels are 39 3 inches in diameter, the same size as the trailing wheels. The auxiliary driving axle has its bearings in pedestals which are formed by plates riveted to both sides of the main frame. This axle has not any ordinary bearing springs, but is connected with the springs of the main driving axle in such a way that these springs tend to lift the auxiliary axle from the rails and press its bearings against the upper stops. Normally, therefore, the auxiliary driving wheels remain 1.2 inches above the rails. When the auxiliary engine is to perform its duty, the auxiliary driving axle is depressed by the action of the piston of a vertical steam cylinder of 16.2 inches in diameter, fixed above its centre. The piston with its ball-socket joint and bronze foot-step bears against a cast steel support, fixed between two plates which connect the bearings. Steam is admitted through a three-way cock, which is seen on the right-hand side of the dome in the perspective view.

The levers between the auxiliary axle bearings and the bearing springs of the main driving axle serve the further object of equilibrating the load when the auxiliary axle is lowered, in such a way that the load is distributed over the running wheels. When the auxiliary wheels are pressed down the whole engine is raised about 1 inch on the springs; at the same time, however, the front links of these springs are depressed by about 2 inches, so that the deflection of the springs, and consequently the load upon them, remain unchanged. When the auxiliary motor is out of use the weight available for adhesion consists of the dead weight of the main driving wheels and their attachments, amounting to 3.73 tons, plus the load on the driving springs, amounting to 11.12 tons, making a total of 14.85 tons. When the auxiliary axle is pressed down, however, the following additional adhesion weight becomes available:

	Tons.
Deadweight of auxiliary axle and its attachments	2.130
Pressure on piston of loading cylinder	17.330
	19.460
Less upward pressure exerted at the point B by the levers connected to the driving springs	4 635
Additional adhesion weight	14.825

It will thus be seen that the adhesion weight amounts to 29.67 tons when the auxiliary axle is being used, and to 14.85 tons in the other case. The total pull of the engine is 14,462 pounds.

The cylinders of the auxiliary engine, which have a diameter of 11.4 inches and stroke of 18.1 inches are bolted to the lower side of the large cylinders; their valve chests lie horizontally and point outward.

The throwing in of the auxiliary engine has taken place when the locomotive was running at speeds up to 46.6 miles. The operation was so smooth that persons standing on the engine and and not watching the driver did *not notice the change over.* It has, moreover, been found that the switching in will rarely be required while the locomotive is in motion. It soon became apparent that the help of the small engine was needed over short distances only.

The complicated construction and the large number of axles have been commented upon adversely. With regard to the

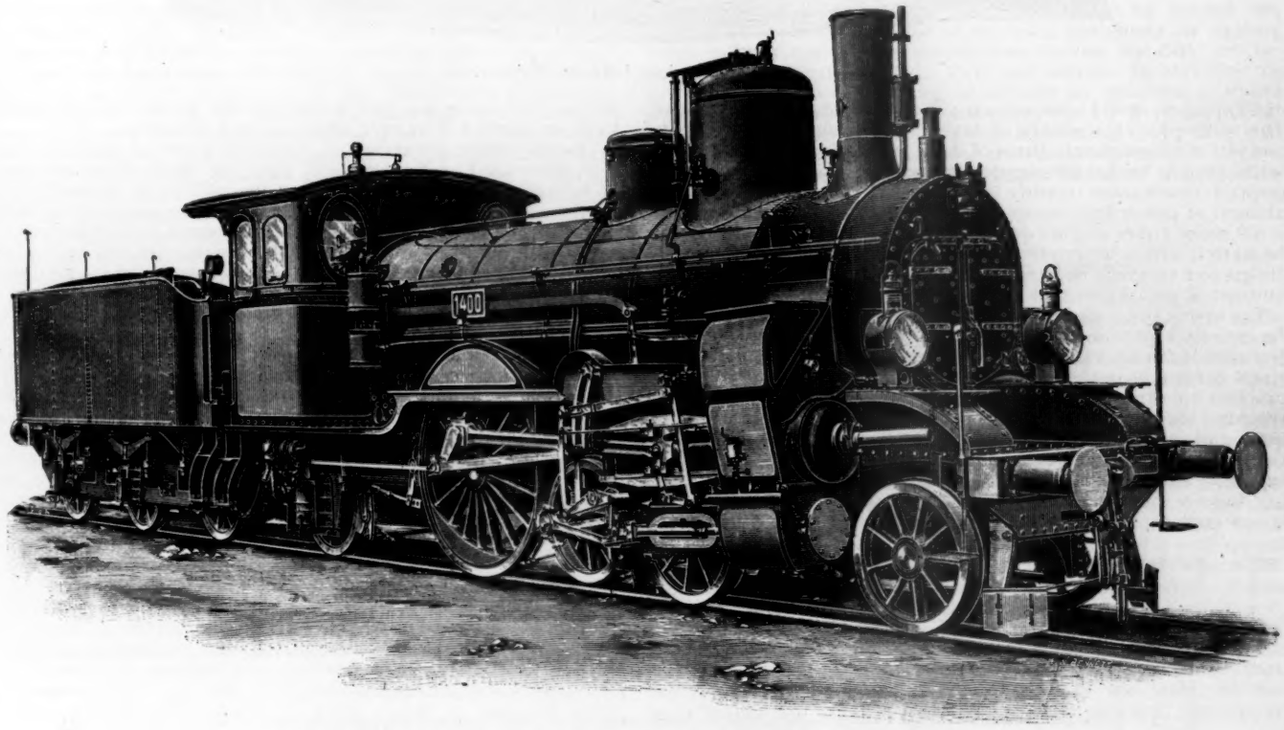
former point, it may be said that the four-cylinder engines of Mallet and De Glehn, whose right of existence nobody questions now, are certainly not any simpler. A four-coupled engine of the latter type has, on the contrary, two more coupling-rods and four more bearings, and the secondary mechanism is essentially more bulky than the auxiliary engine. It is further to be considered that De Glehn's secondary mechanism is always running, which means additional friction, oil and repair. With the auxiliary engine under notice, which is idle for 95 per cent. of the run, those additional expenses come in to the amount of 5 per cent. only. There is a further advantage as compared with compound locomotives fitted with change-over gear, in being able to work with fresh steam in both engines. Such locomotives have to resort to strong throttling, and hence to waste steam, while the main and the auxiliary engines of Messrs. Krauss & Company work with full boiler pressure.

As concerns the second point, the locomotive has exactly as many driving and carrying axles as the "American Atlantic" type, which is more and more coming to the front. Together with its three-axled tender, it has not any more axles than the normal "American" class, with its four-axled tender.

by the steam railway companies, and they are looking with great interest to some method that will enable them to give similar service without having to resort to the enormous expense incidental to the use of electrical equipment.

One of the most interesting of the articles that have appeared lately on this subject, is published in the *Engineering Magazine*, May and June, 1897, by Charles H. Davis, who is an authority on electrical railway matters. Mr. Davis starts out as an advocate of the introduction of electricity into suburban and inter-urban traffic, and his first article might lead one to believe that there is something to be gained by steam railways in making such a change, as he gives for comparison the amount of business done between steam and electrical railways in New England, showing the very large increase in numbers of passengers per mile and increased earnings per mile of electrical over steam railways, but his comparison is hardly fair, as the electrical railways considered are in centers of immense populations. If steam railways were operated under similar conditions the comparison would be fair, but the steam railways are taken for the entire New England States, reaching across large sections of country, where the population is not so dense as it is in the sections where the electric railways are operating.

Mr. Davis starts out as an advocate of the use of electricity for suburban and inter-urban traffic only, and carefully states that it is only to be considered for these purposes and that he does not advocate it for the use of long-distance traffic or for freight, and



Locomotive with Auxiliary Driving Wheels, Bavarian State Railway.

Electricity Under Steam Railway Conditions.

BY GEORGE S. STRONG.

(*First Paper.*)

Much has been written within the last few months regarding electricity taking the place of the locomotive for steam railway work, and a great deal has been said by the daily press, as to the possibility of electricity driving the locomotive out of use. Much of this talk is absolutely without backing in the way of facts, and very labored efforts have been made by electrical railway engineers to prove that, by the adoption of electricity, steam railways are in some way to reap a benefit, although they arrive at the conclusion that it is going to be very much more expensive in first cost and cost of operation; but somehow, they figure out that, by reason of the use of electricity, the traffic is to be so much increased as to warrant the increased expenditure. There is no doubt that by giving similar service to that which electrical railways give on suburban lines, a large amount of business can be retained and business can be increased by existing lines. The electrical roads have demonstrated that, by frequent train service with a low fare, more people will travel than if they have to wait and be guided by a time-table with higher rates. This lesson is one that should not be lost

his main belief is that, by the special kind of serv ice rendered—that is, very frequent trains that take one from his door to his office, or from the suburbs to the center of the city so as to avoid the use of other means of transit—that the gain is to be made. This is undoubtedly true, and we will endeavor to show that this service can be rendered without the use of electricity.

The main advantage of electricity and the service that is being rendered by it as against steam, is, that one is taken up at his door and landed within a reasonable distance of his office, or in the heart of the city, without having to pay two or three fares to reach that point. Another advantage of the electrical system, or system that can be worked out to operate in competition with it as against the present methods of steam railways, is that the units are much smaller and lighter than are now operated, and they should be operated at a much lower cost per mile.

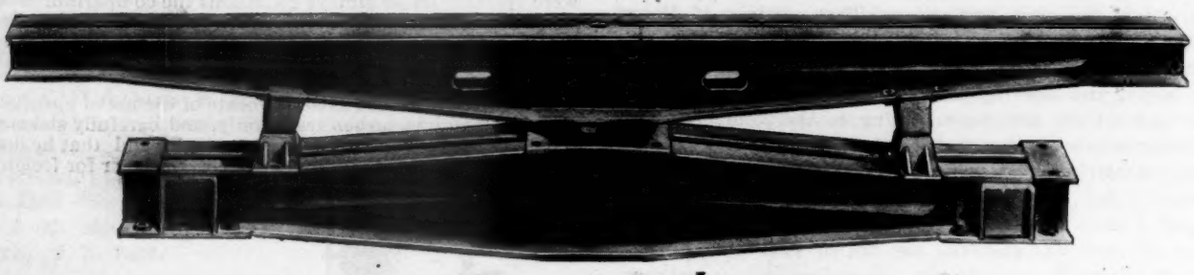
One of the difficulties of modern railway practice has been a tendency toward very much heavier rolling stock, with heavier locomotives, and the point has been reached when the amount of dead weight in proportion to the paying load, is very great. The problem then, for this kind of work, is the development of a motor and car combined that will reduce the amount of dead weight to paying load to a point where the cost of operation will be reduced, and also where, by reason of the reduced amount of dead weight, more frequent stops can be made without loss of time.

The average American train now consists of five cars, each weighing 30 tons, and the locomotive and tender weighing 90 tons, making a total of 240 tons, the seating capacity for such a train being sufficient for about 300 people. Allowing 125 pounds for each passenger would give the weight of 18¾ tons as the paying load, or about 13 tons of dead weight to each ton of paying load. I believe the average American railway practice is 11 tons of train to every ton of passengers.

A motor car weighing 30 tons can be built on modern principles, taking advantage of modern materials, that will have a seating capacity of 100 people, and having motive power on it, entirely independent and self-contained, capable of developing 400 horse-power and capable of hauling, besides its own weight, four other cars of the same capacity, each weighing 20 tons and each capable of seating 100 people. This would give a seating capacity of 500 people, or 31¼ tons, allowing the same weight per passenger. This will reduce the weight of dead load per ton of passengers to one ton of passengers to three of dead load. Such a train as this with proper brake arrangements applied to all wheels, can be stopped much more readily than a heavier train, and with this amount of power and proper roller bearings, can be started with a 400 horse-power engine quite as quickly as a 240-ton train can be started with a locomotive, indicating 600 to 800 horse-power. Its greater carrying capacity would enable it to handle 1¼ times the amount of passengers that could be handled by the heavier train.

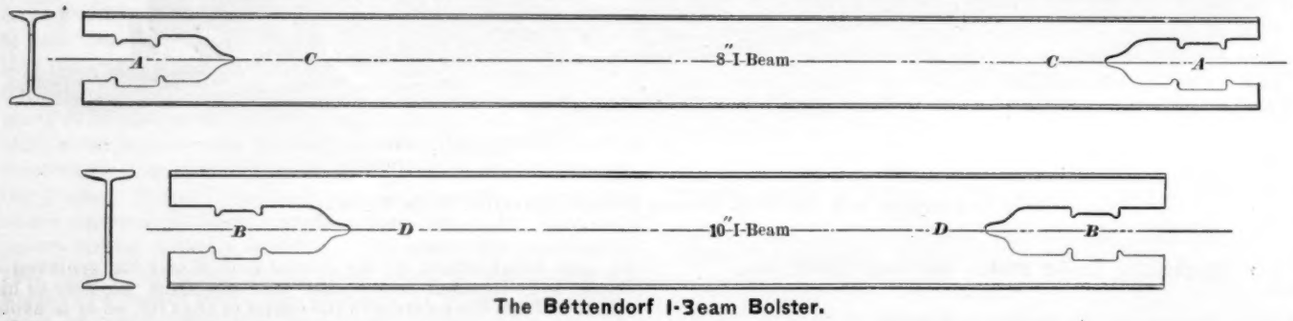
The motor suggested is of such character and so arranged as to be entirely noiseless, smokeless and odorless, and to have no objectionable features that would prevent its passing over ordinary street car tracks in the streets of a city. Then the solution of the problem appears to be for the steam railways to build branches reaching their suburban business and bringing it to their main lines, and running these trains directly over their main lines to their terminals in the cities, and from the terminals on to special tracks which they can own and operate as street car tracks, leading directly into the heart of the cities, and such an arrangement is now contemplated by several leading lines.

It has been found by recent accidents, caused by broken axles on the Brooklyn Bridge cars, that it was necessary to shut off the current whenever an axle breaks before men could attempt to move the wreck, and the men were afraid to go near or to handle the wreck until the current was cut off. Every practical railroad man knows that accidents will happen; and that they generally happen at the place where they are least wanted. A friend of the writer once remarked when an axle broke in a freight train, just as it was passing an engine standing on a siding and piled a number of the following cars upon the locomotive: "I do not see why, with all out-doors to fall into, those cars should have fallen directly on top of that engine." But such is railroading, and the best-managed roads are liable to have broken axles or broken wheels at any time. With the electrical current introduced as another element, and with the entire line being dependent on the continuous and uninterrupted action of this current, such accidents will be very annoying and dangerous.



The Bettendorf I-Beam Bolster.

The only other advantage of electricity over the steam locomotive, advocated by Mr. Davis, is, that the units of power would be lighter and that the pressure on the rail would be continuous, by reason of the motor being a rotary motor, and that the hammer-blow, of which he speaks as being caused by unbalanced reciprocating parts, would be done away with. On the motor that is contemplated to meet this class of business there are no unbalanced reciprocating parts, the motor being entirely balanced so that the pressure on the rail is the same at every part of a revolution and there is no jigging action of the car by reason of unbalanced parts; and the weight on the truck is no greater than it would be with electrical trucks for carrying the same load, and the motors being entirely spring-supported—there being no motor directly on the axle as the electric motor is carried—the action of the wheels on the joints will be very much less destructive than the electric motors. Every street railway manager knows that the electrical motor is not easy on the tracks or on the joints, and it has been found very difficult to keep the joints up on ele ctrica railways. The weight of rails per ton is an evidence of this



The Bettendorf I-Beam Bolster.

Returning to our discussion of Mr. Davis' paper. He advocates the introduction of electricity on suburban roads by a similar system to that described above, and also advocates that, in place of wiring the present lines of steam roads where this kind of business is contemplated, entirely new tracks should be laid parallel to the existing tracks. This would necessitate, of course, the introduction of the "third rail" system, because the new tracks would have to cross yards and other existing tracks, and would bring the uncertainty of the electrical current into the yards where accidents are always liable to happen. One of the bad features of the third rail system, which is not pointed out by Mr. Davis or any of the electrical advocates is, that by its introduction upon existing tracks the liability is always present of having the entire circuit broken by the tracks being torn up by a wreck, or having a short circuit under the wreck on account of an axle or any other piece of iron coming in contact with the third rail and one of the main rails. Such a condition of things would result in the whole line being paralyzed, and would be very likely to result in the wreck being burned; or if people were fastened in, of their being killed by the electric current.

many electric roads now being equipped with 80-pound rails; while, if steam railroads should resort to the same proportion of weight of rails to loads carried, their rails would have to be as heavy as 300 pounds to the yard.

As regards comparative cost of electrically equipped roads to steam roads as they now exist, Mr. Davis arrives at the conclusion that the additional cost of an electrical road over steam roads, is $51,367 per mile for conditions such as would be required for very heavy suburban traffic, and this is the only kind of traffic that has been discussed by him. As regards the cost of operation, he concludes as proven by statistics of electrical roads and steam roads, that, to carry a train of 60 tons at an average speed of 10 miles an hour, the electrical road must burn 48 pounds of coal per train-mile at the power station; while, with the steam train weighing 200 tons and traveling at an average speed of 20 miles an hour, only 58.8 pounds of coal per train-mile are required. This would give for the electrical road a movement of 2,500 pounds for one mile per one pound of coal, and for the steam road a movement of 6,802 pounds for one pound of coal, or nearly 2¾ times the amount of weight moved the same dis-

tance for a given amount of fuel. Now, as a fact, at this rate of speed—a speed of 11½ miles per hour—we have moved cars weighing 75,000 pounds one mile for $2\frac{35}{100}$ pounds of coal on a steam road.

As regards the efficiency and coal consumption, as further stated by Mr. Davis, he gives 2½ pounds as the amount of coal necessary to generate one indicated horse-power, at his power plant under the best conditions on an electric road, and then allows 90 per cent. efficiency for the engine, 90 per cent. efficiency for the dynamo, 80 per cent. efficiency for the line and 75 per cent. efficiency for the electrical motor, giving a combined efficiency of only 48·6 of the indicated power of the engine in the station, and states that the coal consumption for a horse-power actually developed on the motor would be 5·1 pounds, while he gives 5·5 pounds as being the average of steam railway locomotive practice in this country, stating that at times this latter figure will fall to 4½ under the best conditions.

Now, while we are discussing new methods and new appliances to meet new conditions, why not consider the best that can be done by the steam motor? The writer has tested a number of locomotives that have been in operation for long periods, that have shown their ability to produce a horse-power, under average conditions of railway work, for three pounds of coal, and is willing to undertake to design and construct locomotives to-day that would do their work on 2½ pounds of coal per horse-power per hour.

In regard to this question of the economical performance of the locomotive or steam motor, as against the electrical system, the writer would state that there never was a greater fallacy than the one that is being constantly circulated, to the effect that the locomotive is necessarily a wasteful machine, while the stationary plant for generating electricity is much more economical. That it is a fallacy is proven by Mr. Davis' own statements, quoted above. While 2½ pounds per indicated horse power is given as the amount of coal necessary to generate one horse-power under conditions of an electrical generating plant, and while this is possible and entirely probable with a plant working under full load—as will a plant operating a street railway system, where a full load is maintained most of the time—under conditions of suburban and inter-urban work, where it became necessary to extend the interval between trains to a period of ten minutes, instead of a period of two minutes, or 1½ minutes, as on street-car work, the electrical generating steam engine is working under the worst possible conditions for economy, and it is running more than half the time without load. During this time it is consuming a large amount of power without results, and the cylinder becomes merely a condenser of steam, and under these conditions it cannot be expected that an engine will indicate 1 horse power on 2½ pounds of coal; but rather, under these conditions, it is most probable that an engine will use from four to five pounds of coal. The average electrical plant to-day—if we take the average in street railway work—will be found to be using more than 4½ pounds of fuel per horse-power indicated in the station, and if we take 48.6 as the efficiency as stated by Mr. Davis, the motor will require more than 9 pounds of coal to be burned in the station to give one horse-power on the axle.

On the other hand, if we consider the steam motor under the conditions on which it would work in this kind of service we find that it is working under the most economical conditions that a steam motor or steam engine can work under; that is, it is giving a very high amount of power for a given amount of cylinder; the pressures are high and the cylinder condensation is low. As an instance, on a locomotive we have gotten as high as 1,810 horse-power out of a pair of 20 by 24-inch cylinders, with a heating surface of 1,848 square feet, or nearly a horse-power on every square foot of heating surface in the boiler, and 30 horse-power for every square foot of grate area, while if we were to design a stationary engine to indicate this amount of power we should put in a pair of 30 by 48-inch cylinders, which would necessarily have a much larger amount of cylinder condensing surface, and as cylinder condensation is well known to be one of the largest losses that a steam engine has to contend with, amounting to from 20 to 25 per cent. of the total steam used, we can readily see the importance of getting the most out of the least amount of cylinder surface. While some engineers have banked largely on the fact that with the stationary engine plant they might be able to use a condenser, it is found that by going to a high pressure and getting a great amount of power out of a small cylinder nearly the same results can be attained without the use of a condenser, and that with 200 pounds pressure and a properly designed compound engine a horse-power can be obtained for about 16 pounds of water.

On the steam motor we have under consideration 80 per cent. of the exhaust steam is condensed and returned to the tank from which the boiler is fed, only 20 per cent. of it being used for the blast, or to create the draft for the boiler. This, of course, insures hot water feed to the boiler, the absence of which in it itself is one of the largest sources of loss in an ordinary locomotive, as much as 22 per cent. of the heat being required to bring the water up to 212 degrees and feed it into the boiler with an injector as used on ordinary locomotives.

Another great source of loss in ordinary locomotives is that a large amount of fuel is consumed while the engines are not actively in operation and not doing work. The writer has known of as much as 1 ton of coal and nearly 2,000 gallons of water being used while an engine was standing on a siding waiting for a train. The old way, which is still in use on many roads, is for an engine to make a certain run and then go back to the roundhouse or on to a siding, where it is allowed to stand for many hours and cool down, or to keep steam up by constantly burning coal, and to blow steam through the safety valves, simply from the want of management on the part of the fireman and engineer, and on the part of the manager in allowing an engine which might be working to be sidetracked or put away, when she might, on local trains, take out another train at once, if not with the same engineer and fireman, with another crew.

The secret of economy, with any equipment, is to keep it constantly at work, only allowing such time to intervene as is necessary to coal, oil, clean and make necessary repairs. With such a motor as we are considering, and with electrical equipment, this is what is done. The cars are not allowed to remain idle, but are constantly in operation during the working hours and, of course, are earning money, and not deteriorating by reason of changes of temperature by cooling down and heating up again, as is done with ordinary locomotives in ordinary service. The motor we are considering is entirely automatic as to its fuel supply, and the fuel supply is cut off as the boiler approaches the blow-off point, and as the steam pressure decreases, the fuel supply is renewed, so that no heat is being generated unless there is work for it to do.

It is evident from Mr. Davis' figures that what he started out to prove—that is the economy of electrical equipment as against steam railway equipment—has not been proven, but that the reverse has been demonstrated. Few railroads are in condition today to consider the expenditure of $51,000 per mile for a single track, over that which would be necessary to build steam roads, or to build new lines to take the place of existing lines that can be operated by simply introducing new methods and new equipment that would cost less than the simple wiring of the lines for electricity.

The Bettendorf I-Beam Bolsters.

The bolsters shown in the accompanying engravings are made of rolled steel I-beams of the American Steel Manufacturers' specifications, the forms being the same as are used in steel bridge and building construction and the design admits of making light bolsters which are strong.

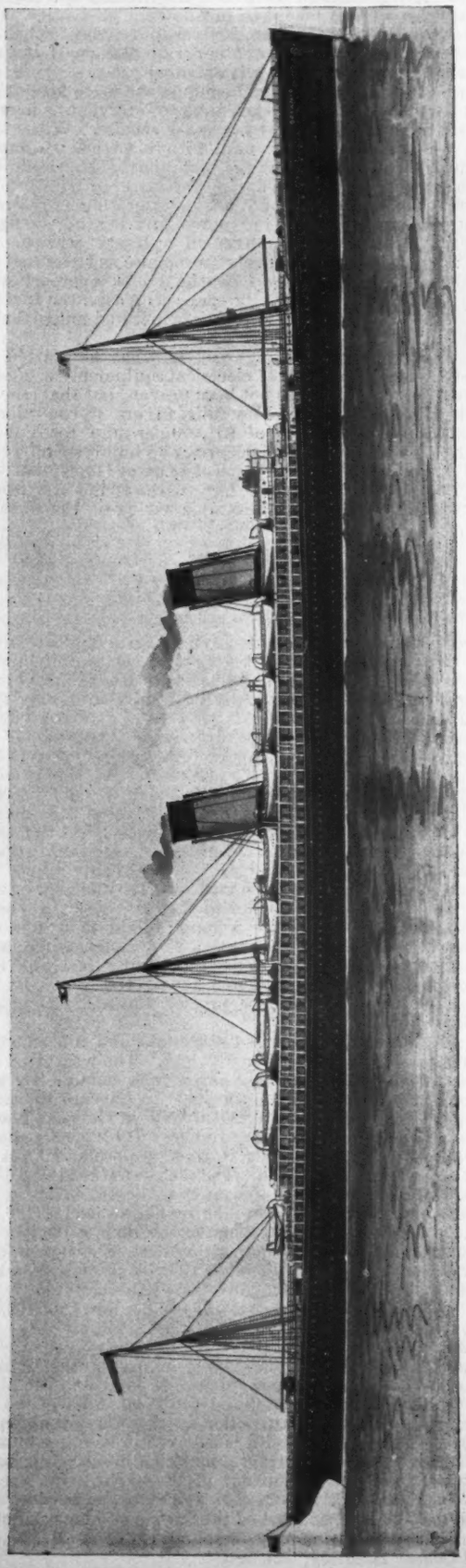
The construction is shown in the drawings. The web of the beam comes centrally under the load on the center plate. The I-beam is tapered or reduced by two processes. At the extreme end over the springs (marked *A* and *B* in the drawings) a section is cut out in such a manner that when it is pressed together the upper and lower parts of the web interlock firmly. At the same time the material from that point toward the center is corrugated or squeezed in, as shown at *C* and *D*. At the point where the portion is cut out and interlocked a butt weld is effected. From the center plate to the side bearings the full strength of the I-beam is obtained, and as the fibre is longitudinal it is not disturbed. The result of this process is that the bolster, when made up, stands about the same load under the testing machine that the two I-beams stand before the reduction of the web. In the body bolster the lower member is pressed upward, the upper flange remaining horizontal.

The weight of the body bolster is 350 pounds, and it is stated to be fully adequate for an 80,000-pound car. The weight of the truck bolster is 450 pounds, and it is also strong enough for any load that can be put upon it in service. In a test of the truck bolster, made by Robert W. Hunt & Company, of Chicago, March 30, 1897, it showed no permanent set after a load of 100,000 pounds, and under a load of 150,000 pounds it took a permanent set of only about one-quarter of an inch. The maximum load was 179,800 pounds. In a test made at the works of the inventor it took a permanent set of only $\frac{1}{16}$ of an inch under a load of 180,000 pounds. It is further stated that when tested on its side it stood a load of 70,000 pounds with $\frac{1}{32}$-inch set, and at 80,000 pounds it took a permanent set of only $\frac{5}{32}$ inch. The body bolster, when tested by Robert W. Hunt & Company, showed a permanent set of only .02 of an inch under a load of 100,000 pounds. At 180,000 pounds the permanent set was 1.01 inches.

The parts of these bolsters are put together without the use of rivets, properly so called. Tubular rivets are cast on the malleable iron parts. They pass through and are expanded in the holes drilled in the steel for the purpose, and are beaded down like an eyelet. The result of this construction is that any strain upon one is borne by all the parts, and it is believed to be impossible to shear a rivet under any but extraordinary conditions. In case of repairs, all that is necessary is to cut off the eyelet with a cold chisel and insert a rivet. In case of a wreck, the bolsters can undoubtedly be repaired, as most of the parts could be used over again. Further information may be obtained from Mr. W. A. Smith, Old Colony Building, Chicago.

The White Star Steamship "Oceanic."

The announcement was made several months ago in these columns that the White Star Line had arranged with Messrs. Harlan & Wolff, of Belfast, for the building of a record-breaking steamship and it was stated that the vessel would be propelled by three screws. Through the courtesy of the *American Shipbuilder* we are able to present an illustration showing the general appearance of the ship when finished and the following is reprinted from that journal:



THE WHITE STAR LINE'S NEW TWIN-SCREW STEAMER OCEANIC. BUILDING BY HARLAN & WOLFF, BELFAST, IRELAND.

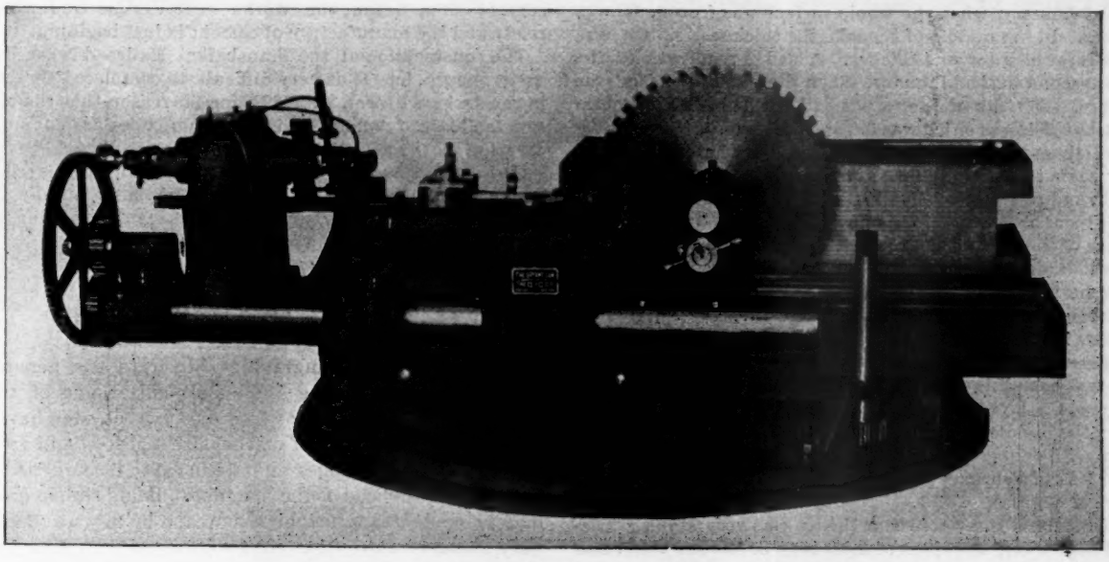
"It would be a pleasure to be able to announce that the gigantic steamer *Oceanic* was to be propelled by triple screws, as George W. Melville, Engineer-in-Chief of the United States Navy, has done so much to bring about the triple screw system in ships of war—the *Columbia* and *Minneapolis* being so fitted—and is anxious to see it adopted in merchant steamers; but, notwithstanding published reports in several of the marine and mechanical journals of Great Britain and the United States that the *Oceanic* would be driven by triple screws, we must now put to rest such a theory by stating that the *Oceanic* will be a twin-screw steamer. The supposition that the vessel was to be a high-speed craft with engines of 45,000 or 50,000 horse-power probably influenced our British and domestic contemporaries in stating that three screws would be used. What the power of the engines is to be the owners and the builders do not care to say at this stage of the construction. But we can state positively, upon the authority of H. Maitland Kersey, that triple compound engines will be used, and not quadruple expansion engines. The theory that it might not be safe to transmit more than 20,000 horse-power through one shaft, gives rise to the belief that the combined engines will not indicate more than 40,000 horse-power and it is surmised that a speed of not more than 21 or 22 knots can be obtained from that power. Indeed, some engineers doubt if over 20 knots can be developed in the *Oceanic* if the engines are not capable of more than 40,000 horse-power. Be that as it may, the *Oceanic* will be the most magnificent as well as the largest steamship afloat, being larger than the *Great Eastern*, as will be seen by comparing the figures.

The *Oceanic* will be 705 feet long, 685 feet on the water line, 68 feet beam, 50 feet deep, 27 feet draft, and 17,000 tons, gross. The *Oceanic* will be launched in January and is expected to be ready to make her first trip to New York in the following June. Next to her great size, the most striking feature in the new ship is the fact that no special effort will be made to surpass all previous records in the matter of speed. Hitherto, it is safe to say, speed has been made the first consideration, and to this all other elements, such as carrying capacity, comfort and economy, have been made strictly subordinate. Now, of all the features that go to make a first-class Atlantic passenger ship, speed is by far the most costly, and when it exceeds 20 knots an hour, the most doubtful in its utility. The enormous sacrifice at which high speed is obtained is proverbial. The *Oceanic* will be an enlarged *Majestic*. She will have two elliptical funnels, three masts and the twin screws will overlap, the starboard shaft extending further aft than the other to give clearance for the propellers. The shafts will be carried out in a spectacle frame, an arrangement in which the plating of the ship is built out and around the shaft, forming a tubular protection which extends up to the stuffing box gland, and allows the shaft to be inspected at all times. A long turtle deck will extend from the bow aft for over 150 feet. The dining saloon will be placed amidships, and above it will be an unusually large and handsome library. Altogether, provision will be made for carrying 350 saloon passengers with such surroundings of comfort and luxury as have never been attempted before, and the provisions for the other classes of passengers will be on a similar scale. In closing, we may say that the *Campania* has engines of 30,000 horse-power and has developed 22 knots an hour. She and her sister, the *Lucania*, have the most powerful engines afloat.

An Electrically Driven, Bryant Cold Saw.

The general appearance of a newly designed cold metal, sawing machine of the Bryant type which has just been brought out by the Q & C Company is shown in the accompanying engraving. This machine is known as the "No. 15," and it is mounted upon a circular base and is adapted to be driven by an electric motor. The arrangement was made with a view of the requirements of structural iron and steel work such as bridge building, and for any work in which beams, channels and angles are used. It is adapted to general work also, and has a large capacity, the lead-

ing idea in the design being to furnish large capacity for a low cost. This machine contains several improvements, among which are increased feeding speeds, prolonged life of saw blades and lateral adjustment of saw blades. The feeding mechanism has been much improved, and the change can be made from slow to fast, or *vice versa*, without stopping the machine. The saw carriage is provided with quick return operated by a rack and pinion. All bearings are adjustable to compensate for wear, and the machine throughout is made of the best material. The saw



The Bryant Cold Metal Saw.

arbor is of Jessop steel and the worm wheel of phosphor bronze engaging with a steel worm.

The engraving shows the method of attaching the motor, and the machine is also furnished on a stationary base with tight and loose pulleys for direct belt power. The weight of the machine is 7,000 pounds. A three horse-power motor is required to run it and the speed of the driving shaft is 140 revolutions per minute, while that of the saw is 3¾ revolutions. The feeding speeds are ¼, ½, ¾ and 1 inch per minute. The saw arbor is 3 inches in diameter and the driving shaft is 2¼ inches in diameter. The sprocket is of cast steel, diameter 6½ inches. There are two work tables, the upper one being 20 by 48 inches and the lower one is 22 by 18 inches. The capacity on solid work at all angles is 24 by 10 inches and the horizontal travel of the saw is 28 inches, the available diameter being 10 inches above the upper table. Saws of a thickness of ¼ inch are used and an adjustment is provided for the sprocket for taking up a wear of the saw amounting to 6 inches. The base swivels 90 degrees and is operated by a segmental rack and pinion. Each machine is accompanied by two saw blades, a grinder, an oil pump for lubricating the saws and the usual tools for adjusting the machine.

The machine is well adapted to sawing out frogs and switch-points and similar work in connection with track construction. The street railways have found the machine to be very useful in track work and it is equally well adapted to the handling of the rails of steam roads. The manufacturers may be addressed at the Western Union Building in Chicago, and at 100 Broadway, New York.

The Westinghouse High-Speed Brake.

A copy of a new publication entitled "The Westinghouse High-Speed Brake" has just been received from the Westinghouse Air-Brake Company. It is a valuable addition to the literature of the air-brake and describes the newly-developed apparatus for application to high-speed trains. This improvement will form the subject of an illustrated article in the August number of this journal. The new apparatus is a distinct advance in the art of air braking. It has been designed to meet the exceptional requirements of regular trains which are scheduled to run at much higher average rates of speed than have heretofore prevailed in passenger train service. The high-speed brake is designed to stop passenger trains in emergencies in about 30 per cent. less distance than is required with the best brakes heretofore used. The brake apparatus employed to do this is of the standard Westinghouse quick action type, with a pressure-regulating attachment. The addition of this latter device, to the existing quick-action brake for locomotives and cars is all that is required to convert them into high-speed brakes, and the superior stopping power is obtained by increasing the standard air-pressure of 70 pounds to about 110 pounds and taking advantage of a well-known principle in braking.

The Great Siberian Railroad and the Present State of Its Construction.

(Special Correspondence to the *American Engineer, Car Builder and Railroad Journal.*)

(CONTINUED FROM PAGE 175.)

IRKOUTSK-MISOVSKAIA.

The connection of Irkoutsk, the terminus of the Central Siberian Railroad, with the harbor Misovskaïa, the starting point of the Transbaïkal Railroad, was originally designed as a continuous railroad, the Baïkal loop line. But as the preliminary surveys of this Baïkal loop line, along the south shore of Baïkal Lake, has shown that the construction of this line will be very difficult and require much time, and that more accurate surveys are necessary. It was decided in order to obtain the continuous steam connection between Chelabinsk and Vladivostok to build the branch from Irkoutsk to Baïkal Lake, and to arrange for a steam ferry across the Baïkal Sea.

The construction of the branch from Irkoutsk to Listvinichnaïa, a landing place on the west bank of Lake Baïkal, along the left shore of Angara River (43 miles), was endorsed by the Emperor in June, 1896. The construction will be completed in autumn, 1898; it will cost (without rolling stock) $1,264,000. The work began in August, 1896, and without doubt it will be completed in the assigned term.

In order to carry out the plans for the steam ferry across the Lake Baïkal, it was necessary to build two harbors on the western and eastern bank of the lake, to buy an ice-breaking steam ferry for the transportation of whole trains, and to build one wooden floating dock.

The cost of ferry, harbors and dock is estimated at $1,687,000. All this work will be completed in autumn. 1898.

The ice-breaking steamer has been built by the Armstrong Works, in England (for £70,000); it has 4,300 tons displacement, the length is 290 feet, width 57 feet, and greater draft 20 feet. The

engine is of 3,750 independent horse-power. The upper deck bears three pairs of rails, which can carry 20 cars. The steamer is already completed and in small portions is being carried to Krasnoiarsk. From there it will be transported to Lake Baikal, and put together in the wooden floating sectional dock.

In order to have a more exact idea on the natural conditions of the Lake Baikal, exact meteorological observations have been made. These observations, made in Misouskaia, on the eastern bank of the lake, gave the following results:

The ice began to form in the middle of December; its thickness was two inches. The thickness of ice gradually increased, and in the middle of January, when the whole surface was frozen, it was 12 to 16 inches. In the middle of the lake the thickness of ice was less and the layer of snow was thicker. A sledge road was established in the second half of January, when the thickness of ice was 12 to 16 inches. The 30th of January it had reached 16 to 20 inches.

The greatest thickness of ice was 3 feet in the end of March, after which the thickness of ice decreased. The eastern half of the lake (from Misovshaïa to the middle) was covered with snow about 10 inches thick, and the western half (from Listvenichnaïa to the middle) was more or less free from snow.

The surface of the ice in different parts of the lake and in different directions shows fissures, the wide of which reaches 10 feet. These are sometimes covered with inclined ice blocks 3 feet high, or with horizontal blocks 20 feet wide. The greatest number of fissures occurs in March.

The average monthly temperature of the lake in February (— 15.4 degrees C.) was something lower than on the shore; in Misovskaïa (— 14.1 degrees C.), and in Listvenichnaia (— 15.1 degrees C.). The minimum in the middle of the lake was —24 degrees C. February 25; maximum, 5.5 degrees C. February 17. The greatest amplitude of variation was in February 18.6 degrees, in March 26.4 degrees, and in April 22 degrees.

The temperature of the water near the ice was very stable (variations ¼ — 1 degree C.); at depths of more than 35 feet the water had during the whole winter the constant temperature 3¼ degrees C.

The clearing of Baïkal begins at the western bank (Listvenichnaïa) and then at the eastern shore (Misovshaïa). The first trip of the steamer was made May 12, and May 22 the ice had disappeared.

In consequence of this it is expected that the trains could be transported across the Lake Baïkal by the ice-breaking steam ferry during 10 months in the year. The remaining two months the trains will be carried on tracks laid over the ice.

The surveys and location of the Baïkal loop line was designed in 1894 and a sum of $107,500 was appropriated. The survey was commenced in 1896 and will be finished in 1897. The construction of this line is still a question of future time. The length of the line is 161 miles, the ruling gradient 0.018 (1.8 per cent.), minimum radius of curve 840 feet, and a tunnel 13,800 feet long shall increase the cost of construction.

THE TRANSBAIKAL RAILROAD.

The Transbaïkal Railroad, according to its final location, has the following length:

From Misovskaia on Lake Baikal to Sretensk on Shilka River	687½ miles
From Sretensk to Pokrovska	241 "
	928½ miles

The preliminary surveys were made in the years 1887 and 1888; the definitive location in 1893 and 1894, and the line is located, as before, along the Khilok River.

The cost of the first division from Misouskaïa to Sretensk, together with rolling stock, is estimated $33,040,000 or $43,780 per mile. The second division probably shall not be built next time.

The construction of the Transbaïkal Railroad was commenced in 1895 and at the end of 1896 the progress of works was represented by the following figures: 11,430,000 cubic yards of earthworks completed, or 50 per cent. of the whole; 32,450 square yards of pavement of grading slopes; 84,000 cubic yards of retaining walls; 273 miles of provisory roads; 9 miles of horse roads; 81 provisory buildings and 14 dynamite stores are constructed, and 30,000 tons of rails are shipped. Besides them there are in construction 8 stone culverts, 56 timber bridges, 24 temporary timber bridges, 50 stone bridges with timber girders, 8 stone bridges with iron girders and 4 great bridges. The track is laid on four miles only. There are in construction 8 watchmen-houses, 36 small section houses, 48 great section-houses, 20 wells, 19 passenger-houses, 6 engine sheds, 1 small repair workshop and the great repair workshop in Chita, 74 houses for employees, 5 water stations, 4 pumping-houses, 1 hospital, 3 storehouses, 3 blacksmith shops, 26 wells for station water supply. The telegraph is ready on 400 miles. Many provisory houses for workmen and workshops are built; 157,000 ties are prepared. The number of different workmen is 14,300, and there are 1,078 horses.

In order to supply the Portland cement for the stone-work of the Transbaïkal Railroad, two cement works have been constructed in the country: the Kokyrtaïsk works and the Briansk works. The first of these works, near Nerchinsk, will manufacture 40,000 barrels yearly, and the second, near Werkne Oudinsk, 20,000 barrels yearly. Both works have received a government order of 300,000 barrels in five years, at the price of $8 per barrel. The works near Nerchinsk were ready in autumn, 1895, and the manufacturing of cement then began; the works near Verkne Oudinsk are now ready and the manufacture of cement is just begining.

The construction of the Transbaïkal Railroad is carried on with great energy, but it is very difficult to complete the track-laying in the designed term, viz., 1898; for the reason that the transportation facilities of Amour navigation companies are not sufficient for carrying all the necessary materials.

Having in view the scarcity of habitations in this country, the administration of the railroad contemplates building, near the Chita workshops, a settlement for workmen, consisting of 70 small houses, each of four or two tenements.

(To be Concluded.)

The Acme Bolt Cutter.

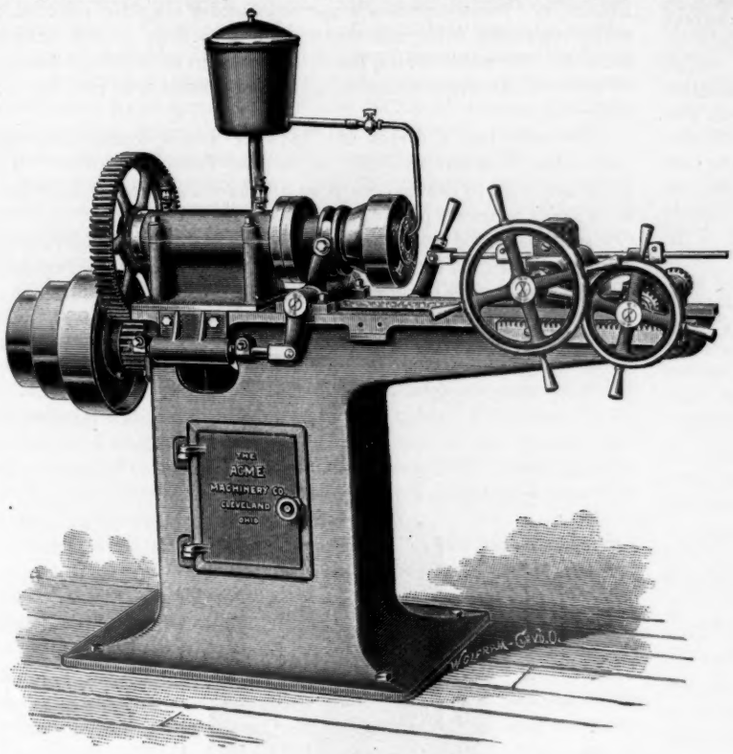
The accompanying engravings illustrate the general appearance of two forms of the Acme bolt cutter, one of them being new. These cutters employ four dies in a set, each having a solid end bearing. They are of market size tool steel and are carefully ground to standard gages and are made to fit hardened tool steel bushings in the head of the machine. Being simple in form they may be made in any machine shop and by any mechanic of ordinary ability. The cutters are furnished in sizes from ¼-inch to 1¼ inches, inclusive. The dies furnished by the company are all provided with hardened tool steel caps made on the interchangeable system and the caps may be used over and over again with new dies.

The machine first shown is of the single head type. They are also made with double and triple heads, and single headed machines are made of sufficient power to cut threads as large as six inches in diameter. The matter of lubrication has been carefully considered in this design. The spindle which carries the cone pulley at the left of the machine has a crank pin on its inner end, within the hollow base forming the support to the machine and a small reciprocating oil pump is driven by a connecting rod. The position of the crank pin with reference to the center of the shaft is adjustable whereby the stroke of the plunger may be varied to govern the amount of oil delivered. The base of the machine is solid at the bottom, forming a receptacle for the oil to prevent its loss. The discharge pipe is carried upward into the oil pot through the center of the overflow pipe; its end is conveyed downward and falls slightly below the top of the overflow pipe, thus preventing the splashing and churning of the oil. The pump is of ample size, so that when running with a slow speed plenty of oil is supplied to the cutters. With this lubricating arrangement the machine may be kept as clean as any lathe.

The "Acme Head" supplied with these bolt cutters is composed of but three parts, the barrel, the die ring and a clutch ring. The barrel is made of cast iron, turned, milled and bored perfectly true. To the front end is fastened a face plate which serves to hold the dies and die bushings in place. In the outer surface of the barrel there are four longitudinal grooves milled to within a short distance of the flange, and in these grooves are fitted tool steel strips hardened and ground to resist the wear of the sliding die ring. These strips are fastened to the barrel with screws, so that even after years of service all wear between die ring and barrel can be taken up. The die ring is made of cast iron, the inner surface of which has tool steel strips hardened and ground to correspond with those in the barrel. This ring controls the movement of the dies radially to and from the center, by means of recesses, milled at an angle of 15 degrees from its face. The bottoms of these recesses are lined with tool steel to resist the wear of the hardened steel die caps. The clutch ring is made of cast iron, having an annular groove to receive phospher bronze seg-

ments that are attached to the automatic opening and closing device. The movement of this ring is transmitted to the die ring through the rocking lever and toggle.

An important feature of the Acme head is that of the die ring being connected directly to the barrel. The rocking lever, link



The Acme Bolt Cutter.

and adjusting screw form this connection in a very efficient manner. When the head is closed the middle center of the toggle passes below the end centers $\frac{1}{100}$ of an inch, and does not affect any movement of the die ring in so doing. But it forms a lock which cannot yield to any pressure produced in cutting threads. The adjusting screw is made with a fine thread so that bolts may be cut to the exact size required, and when adjusted, it is clamped firmly in place by means of a threaded bushing. All heads are supplied with an index, and when a record is kept of the dies, the head may be set to cut the required size without the necessity of making several cuts. The construction is simple, making it easy to adjust and operate, and all moving parts are so arranged that it is impossible to clog with chips and scale.

An interesting improvement in the form of a pneumatic turret attachment to these machines is shown in the second engraving. This is the invention of Mr. H. A. Fergusson, Assistant Master Mechanic at the Meadows shops, Pennsylvania Railroad. This attachment, which consists of a turret revolving on a slide, may be easily removed and replaced from the machine in a few minutes, and it may be applied to any machine of this company's make. It is operated by compressed air from a small supply pipe under the bed of the machine. The turret has spaces for six bolts, and the entire duty of the operator is to keep the spaces filled, since a small cylinder under the slide does all the rest, ejecting the bolt when it is cut, closing the dies, and revolving the turret presenting a new bolt.

The construction of the turret is such that it can be rapidly set for another size of bolt, the machine otherwise being set in the usual way. The amount of work that can be turned out by using these turrets is stated to be more than twice as much as can be done on other machines, and with less exertion by the operator.

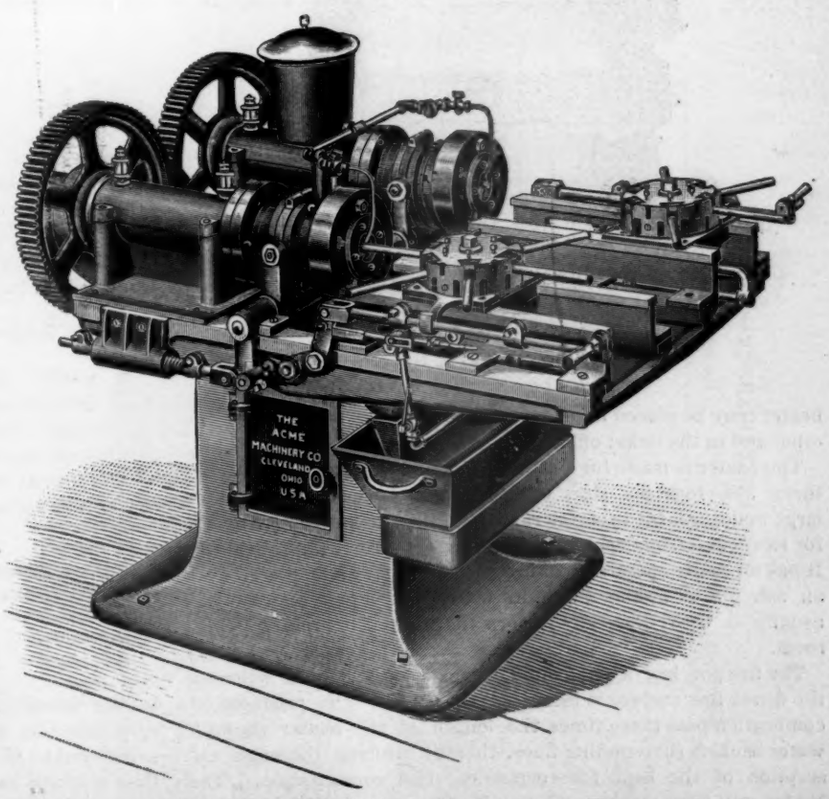
One of these machines was exhibited at the recent conventions at Old Point Comfort, from which it was seen that the workmanship throughout was of the best, and of a quality that will undoubtedly insure long wear of parts.

These pneumatic turrets are designed to increase the rapidity with which bolts may be cut, not by altering the speed of the die heads, but by reducing the time taken to close the dies and remove and replace the bolts, their action being entirely automatic, each bolt being ejected and a blank started in a fraction of a second. It is stated that $\frac{5}{8}$-inch bolts have been cut with it at the rate of 800 per hour, the machine having cut 7,200 bolts of this size in 9 hours running, the work done being good.

The machine is a decided novelty and seems to be designed upon good principles of mechanics as applied to such work. The use of air pressure has two specially good features. It offers an elastic push of the bolt which is yielding if a heavy resistance is met and it assists the dies in relieving them of the necessity of drawing the bolt along while cutting. A spring backing to the head of the bolt prevents shock when the bolt touches the dies. It may be said that this machine is an important improvement over others in output and that no sacrifice of quality of work is made, the product being fully as good as that by the old method.

The Latest on Tonnage Rating.

Experiments have recently been carried out by Mr. S. P. Bush, Superintendent of Motive Power of the Pennsyl-



The Acme Bolt Cutter, with Pneumatic Turret.

vania Lines, upon the effect of varying the number of cars in trains and the weights of trains. It was found that the generally accepted opinion was true that the variation of the number of cars with a con-

stant weight of train had a greater effect on the fuel consumption of the locomotive than does a change in the weight of the train. The experiments were conducted on the line between Logansport, Ind., and Chicago, a distance of 115 miles, and they were divided into two series, the first of which employed trains of equal weight, but varying number of cars and the second used trains of equal numbers of cars, but varying in weight. The tests on trains of the same weight but variable number of cars showed that the fuel consumption increases uniformly with the increase in the number of cars. When the trains were composed of equal numbers of cars, but variable weight the results were not regular and uniform, but it was evident that the consumption of fuel for any given number of cars was comparatively constant no matter whether the cars were lightly or heavily loaded. In one instance an increase in fuel consumption of only about 400 pounds was found with a 32-car train, when the load was increased from 750 to 1,050 tons. The conclusion reached by Mr. Bush was that as a result of this information it is easily seen that, under the conditions existing on this particular division, an absolute car-mile basis counting each car as a car, whether loaded or not, and making the necessary adjustment of the weight, would be more accurate than to rate engines upon the tonnage system. He believed that the car basis was better for practical purposes of rating locomotives than the tonnage system, and that for all practical purposes the weight could be left out of account entirely.

The Bundy La Villa Heater.

In appearance the Bundy La Villa Heater savors of stove construction inasmuch as it is quite ornamental. It is designed to be placed in a living-room for direct heating and other rooms may be warmed by radiators connected with it. In this manner small railway stations may be cheaply and efficiently heated. The

The Bundy La Villa Heater.

heater may be placed in one waiting-room and radiators in the other and in the ticket office.

The heater is made for both steam and hot water heating, and there are fourteen sizes of each. It is not designed for large buildings, the capacity ranging from 150 to 700 square feet for steam and from 200 to 1,050 square feet for hot water heating. It has an easily operated rocking and dumping grate, placed over an ash pit of ample depth, in which an ash pan may be and usually is used, especially where the heater occupies a living-room.

The fire pot has a corrugated crown sheet and sides whereby the direct fire surface is increased threefold. The products of combustion pass three times the length of the heater through water backed surrounding flues, thereby insuring thorough absorption of the heat for economical fuel consumption. The heater will burn either hard or soft coal, coke, wood or gas. It may be easily cleaned and by opening the front and rear clean-out doors every part of the heater is accessible. All doors are fitted and machined gas and dust-tight. When the grate is shaken all openings are closed as the shaker arm protrudes and no dust, smoke or ashes can escape. The heater is low, only 52 and 60 inches high for the two series. The base extends under the entire heater and it may safely be placed upon a wooden floor. The ashes may be removed in the ash-pan, causing no more dirt than the ordinary stove and the quality of the heat is healthful. The temperature is always under absolute control, is easily regulated, being automatic and according to the manufacturers the heater should last a lifetime and save enough fuel in its economical consumption to pay a very handsome interest on the investment.

This heater has a direct and indirect smoke connection with controlling dampers attached to the automatic regulator. All doors are lined to prevent warping and care and consideration has been given to insure perfect manufacture.

The attention of railroad officials is called to the advisability of using this heater, for while price is not the selling argument, still the cost is very low, and its durability one of its strong

The Bundy La Villa Heater.

claims, so that the placing of this apparatus is believed to practically solve the question of heating every station so equipped.

Further particulars will be given by the manufacturers, the A. A. Griffing Iron Company, 66–68 Centre street, New York, or at their distributing stores and works at Boston, Philadelphia and Jersey City, N. J.

Improved Pressed Steel Brake Shoe Key.

A newly improved pressed steel brake shoe key has just been introduced by the Q & C Company. Pressed steel keys of the Master Car Builders' type were formerly manufactured by the Drexel Manufacturing Company, and the improvement made by the present manufacturers consists in strengthening the key at the point at which it is subjected to the greatest strains, as shown

A New Brake Shoe Key.

in the accompanying engraving. With this improvement the only objection which has been raised against the pressed steel key is believed to have been removed, and while this is much lighter than a forged key it is strong and elastic. The material is a good quality of steel well adapted to the purpose and to the method of manufacture. The price of these keys has been reduced which constitutes an additional advantage to be derived from their use. The address of the Q & C Company is 700 Western Union Building, Chicago, and 100 Broadway, New York.

The Cloud Metallic Truck.

The form of truck which is illustrated in the accompanying engraving is the invention of Mr. John W. Cloud, who is well known to the readers of this journal. The truck is built entirely of metal, of steel and malleable iron and the object of the designer was to produce a truck which should be an improvement over earlier forms. The side frames are of plate steel and the pedestals are of malleable iron riveted to the frames. This construction permitted of placing the springs over the journal boxes. The frames are so arranged as to also permit of the use of elliptic springs which may be placed over the boxes with equal facility. When elliptic springs are used they are placed upon the box with the side frames between them and the pedestal casting comes down to within two inches of the top of the box. It will be seen that the construction followed reinforces the ends of the frames at the points where the strain from the boxes comes.

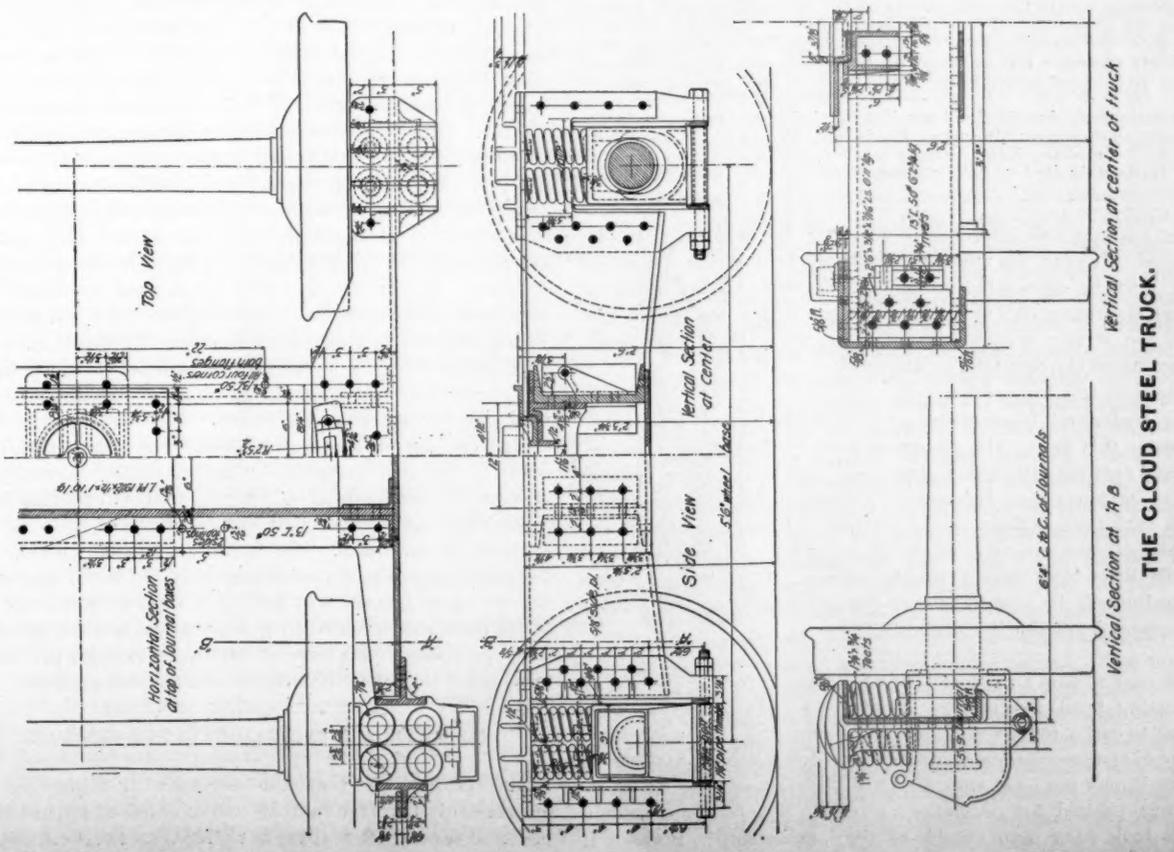
Four coil springs are used, which was considered to be an improvement over the use of one heavy double coil spring, and the use of the four springs tends to distribute the load evenly on the boxes and to keep them perpendicular without causing a tendency to bind in the pedestals. When elliptic springs are used the form of pedestal is slightly modified to receive them. These may be of any desired length and they may be designed for the special service expected of them. The method of placing the elliptic springs will be understood from the drawing which shows the method of attaching the coil springs.

Special attention is called to the form of the side frames and to the provision for the strains which come at the line *AB* in the plan and side views. The bearing of the pedestals against the boxes is 6 inches in width, which is wider than that provided in other forms of metallic trucks. Aside from the assistance which this will give in keeping the trucks square, the wide bearing will give a good wearing surface. The pedestals are secured at the bottom ends by "I" bolts, which are double-nutted and cottered. The proper distance between the jaws is maintained by the use of pipe thimbles.

One of the claims made for the design is that the side frames being flanged on straight lines permits of repairs being made at any shop and without requiring special tools, should they become bent or twisted in wrecks. It will be noticed that the beam for carrying the load is straight on its top, for which special advantages are expected. The transoms are made of rolled channels or of pressed steel plates in the form of channels. The center plate and side bearings are shown made of malleable iron, although pressed steel could be used for these if desired. For trucks with inside-hung brakes, malleable iron brake hanger brackets are riveted to the transoms. The transoms and side frames are united and thoroughly braced by gussets formed by the top and bottom flanges of the side frames. By referring to the drawing it will be noticed that the stiffness of the truck with reference to resisting the tendency to get out of square has not been neglected, the flanges of the side frames having been made wide at their points of contact with the transoms, and in addition to the riveting of the transoms to these flanges, angle attachments are made against the webs of the side frames. It is understood that tests have been made of the trucks, and that results were entirely satisfactory. Further information with regard to these trucks may be obtained from The Cloud Steel Truck Company, 1535 Old Colony Building, Chicago.

During the past 10 years the South has made rapid progress in supplying iron to the trade of this country and Europe. A contemporary points out that it was only a dozen years ago that the first shipment of Southern iron was made to Pennsylvania. At the time it created no small amount of surprise, for it was never believed prior to that time that the South would sell iron in the Keystone State. Statistics on this point show that shipments for April, this year, amounted to 101,141 tons. Of this the West took 38,207 tons, the East 29,996 tons and Europe 32,838 tons. Shipments to Europe so far this year amount to more than 100,000 tons, more than double the amount exported last year. It is expected that total shipments abroad for this year will be more than twice the amount sent last year.

All of the piping of the heating apparatus of the new Congressional Library at Washington, D. C., is covered with Keasbey & Mattison's magnesia sectional covering.


Top View
Horizontal Section at top of Journal boxes
Side View
Vertical Section at center
Vertical Section at center of truck
Vertical Section at A B

THE CLOUD STEEL TRUCK.

(Established 1832.)

AMERICAN ENGINEER
CAR BUILDER AND RAILROAD JOURNAL.

28TH YEAR. 66TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING.....NEW YORK

G. M. BASFORD, Editor.

JULY, 1897.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*
Subscriptions for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn Street, Chicago, Ill.

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Last year the new interchange won the day without a vote by cars and this year the whole of the work of revision concerned what may be considered minor details, with the exception of placing the responsibility for wrong repairs upon the people who make the wrong repairs. The good work of the railroad clubs was apparent throughout the discussion.

The compound locomotive had everything its own way in the discussion this year. The reports of saving effected were reasonable and entirely favorable to the compound type, but it appears that there are great differences between different compounds, and that the proportions of the cylinder volumes may affect the records between various compounds as greatly as the compound records differ from those of simple engines. The laboratory tests at Purdue will be likely to throw further light upon this feature of compound practice in the coming year.

It is easy to pass a resolution in a convention for the purpose of expunging from the printed proceedings anything that may appear to cast a reflection upon the organization. If a standard of one of the associations is ignored by a committee in making its report, it may not look well to have the discussion of its shortcomings printed for permanent record. But how does such a dodge look to a man outside of the membership? Perhaps if these things were placed upon permanent records the authors would be brought to see the value of consistency and in the end less would be heard about the disregard of standards.

A most sensible step with regard to the interchange rules was taken at the recent conventions in putting a stop to the bother which has been had with small bills. This is referred to elsewhere in this issue and along with the action looking toward a simplification of the work of the arbitration committee this must be considered an important improvement. There is another step, however, which might well be taken which consists of the establishment of a clearing-house for interchange repair bills, the purpose being to further simplify the business of setting the repair accounts. The clearing-house plan is being most successfully used between different roads of system lines for the saving of book-keeping and it would appear to be worth looking into with reference to use in the manner suggested.

The steel car has made material progress since the 1896 convention, and at Old Point Comfort last month the question was not as to the advantages of steel over wooden cars, but was: What kind of steel car shall be used? The exhibition of new pressed steel cars attracted much attention and favorable comment, while the Norfolk & Southern pioneer steel car, which has been in use several years, interested those who were concerned with the question of tightness of joints after rough service. In the discussion it was plain that entirely new methods of construction must rule, and the old ideas of trussed frames must be left with the wooden car. The steel girder needs no trussing for spans the length of a freight car, and herein is an advantage of steel construction in avoiding the use of truss rods. The plan of appointing individual members to present designs for steel cars worked well, and that the question involved in this field of designing must be decided by practical experience was made clear by the absence of discussion or of criticism of the plans presented, beyond bringing out the fact concerning trussing just referred to. There is also ground for hope that progress has been made in the direction of standardizing the chief dimensions of cars.

Grade crossing accidents with such consequences as attended the one which occurred at Valley Stream, Long Island, May 31, serve to call attention in a very forcible way to the fact that a large majority of the crossings at grade between streets and steam railroads are unsafe, and are sure sooner or later to become scenes of disasters more or less serious according to circumstances. In the case mentioned a coach load of people was struck by a train and five of the occupants were killed and several were injured. The crossing where the accident occurred was not more dangerous than a vast number of others, and the precautions for the prevention of accidents were not entirely neglected, since automatic bells were provided to give warning of the approach of trains. The public is naturally shocked by disasters of this kind, and severe criticism is poured out upon the management which neglects to make such horrors impossible. As a broad proposition it may be stated that no railroad should be allowed to run trains until every known precaution for the safety of the public and of passengers is taken. It is well to consider, however, what this means to the roads. The worst accidents may occur at the best protected crossing. There is nothing short of absolute separation of the grades that will provide immunity from such occurrences and the expense of this in crowded districts is enormous. It is fair, then, to ask whether after all the public itself has not some responsibility in the matter. There are very good reasons why the roads should be relieved of some of the immense expense of track elevation, and the example of at least one State should have an influence to raise the question as to whether the public is doing its share in the protection of itself.

SELECTION AND ENCOURAGEMENT OF SUBORDINATES.

During the past year the necessity of filling the position of president of a large railroad and of chiefs of important departments of several other roads has offered an excellent opportunity

to obtain an idea of the methods of organization which have developed in various companies. The differences in policy with regard to succession in office are remarkable. The death of the high officer referred to recently caused an advance all along the line, reaching even to some of the subordinate positions. Apparently, in this case, no thought was given to any outsider for filling any position which became vacant through the succession. There is good reason for the succession within this company's own staff of officers, in that the subordinates were fitted for promotion and were prepared for the assumption of larger responsibilities.

The manner of filling vacancies at the heads of departments on several other lines at about the same time was in marked contrast to this method, from the fact that men who were thought competent for the positions, and who were qualified to assume the duties, were not available on the roads. They were sought elsewhere and were placed in charge of men to whom they were perfect strangers. They were also unaccustomed to the methods and the special conditions under which these roads were operated. A thoughtful glance at these two methods of filling vacancies must result in strongly favoring the first, or succession from the ranks. It is not necessary to give undue or unwise consideration to seniority, because fitness for promotion would appear to be the fundamental reason for advancement.

It is said that it is advisable to import or introduce "new blood" occasionally in order to obtain the benefit of new ideas and to avoid drifting into ruts, but the deepest ruts are those into which subordinates run when their hopes for advancement are cut off by a policy of importing heads of departments to be placed over them. The encouragement of certain promotion as a reward for good work seems to be the best rut eradicator which has been brought out. This subject involves the question of the proper treatment of subordinates, even to the lowest, and that chief is likely to be most successful who understands and practises the art of getting the best and most intelligent efforts from all of the force for which he is responsible. The more responsibility an officer has the more he needs advisers, and is not the best adviser one who is in training to take his chief's position?

The chief who selects his assistants with reference to their fitness to succeed him will benefit by his own broadness of mind. He must profit personally because of the incentive which is offered him in keeping ahead of his subordinates, and as they improve he must improve and become more valuable to his superiors, and therefore better qualified for his own advancement. It is believed that many men defeat their own object of promotion by their management of their immediate subordinates. Proper credit and encouragement to these, added to careful selection, would probably be found as advantageous to a man's reputation as the adoption of a carefully developed standard in any branch of operation or construction. A standard method of encouraging education and improvement would be worth formulating.

Technical organizations among men in railroad service are growing in favor, and while railroads are not expected to enter educational fields in general, much may be accomplished by education along the lines of the peculiar problems with which each particular road is confronted. The organization of the employees of a department of one of the most progressive Western lines, which is built upon the following liberal "platform," offers an excellent example of a legitimate and satisfactory educational institution which incidentally furnishes great encouragement to the men.

"No monopoly of knowledge.

"No concealment of ignorance.

"The company is entitled to all the information about its work and business that is possessed by any employee.

"Every proposition or suggestion from an employee intended to promote safety and economy is entitled to respect, and will always receive consideration.

"Employees are trustees for the stockholders.

"We are known individually and collectively by our work."

It is evident that it will not be necessary to import a man to succeed the head of that department, and the principles so tersely stated in this platform are worthy of the most careful consideration and of adoption by railroad officers from president down.

A very successful operating officer on another road follows the plan in hiring men for train crews and service of any similar character of taking as far as possible only those who give promise of capability of advancement. In a paper upon the subject of "Railroad Ethics" this officer said:

"We spend considerable sums for laboratories in which to test the materials which are to be used in construction and repairs; we know the history of every bit of wood, the wearing qualities of our paints and oils, the tensile strength of each piece of iron or steel; we keep careful watch of the working of every new device, noting its performance with the utmost anxiety; but what do we know of the men we employ? How do we satisfy ourselves of their fitness for the work, and, once in the service and charged with responsibility, what do we know of their habits and their tendencies? Employees are too often selected in a hap-hazard way by the head of the department who has need of their services at once with no reference to a higher purpose than present needs.

"More thought should be given to the capacity of the man to fulfil higher duties when called. However good a fireman you may think a man will make, if you are satisfied he has not the capacity to be a competent engineer don't employ him. A man may be strong and nimble enough to do duty as a brakeman, but if he has not the making of a good conductor in him, don't engage him."

The subject of the management of such matters is an important one and is not to be compassed by a few paragraphs, but if a suggestion of its bearing upon the success of a road is here offered the purpose in hand will be attained.

THE COST OF LOCOMOTIVE REPAIRS.

In locomotive departments the greatest expenditures are in three items—wages, fuel and repairs. It is unlikely that shop wages will furnish means for cutting down expenses, but in the use of fuel and the productiveness of men and machinery in the shops appear wide fields for improvement. Mechanical officers have many details to look after, and it is only recently that fuel economy has been given the high place in their thoughts which its importance deserves. It is now, however, a hobby well ridden by many men. Much has been accomplished in this direction during the past four years and perhaps more than in any similar period in the railroad history of the country. The locomotive is studied as it never was before and with shop tests as a basis most excellent improvements have been introduced and yet only a beginning has been made. An illustration of an important improvement is in connection with the recommendations of the committee of the Master Mechanics' Association last year with regard to exhaust nozzles and steam passages from trials of which encouraging reports were made at the recent convention. The importance of fuel economy and efficient operation of locomotives must not be lost sight of, and it will not be, but there is an almost equally important item in shop operation which should occupy attention.

One of the best papers which has appeared upon the subject of locomotive fuel was that by Mr. Wm. Forsyth, read in December, 1894, before the Western Railway Club. That paper has been in a way supplemented by one entitled: "The Cost of Locomotive Repairs and the Efficiency of Machine Tools in Railroad Shops," read by Mr. Forsyth before the same organization at its May meeting of this year. The cost of locomotive repairs was given a place alongside that of fuel cost, and the fact that this subject has been somewhat neglected is generally recognized by those who compare the methods of railroad shops with those of manufacturing concerns. The author of this paper gets at the root of the difficulty, and directs attention to the fact that mechanical officers do not know the cost of the details of their repair work. For this they are, perhaps, not to be blamed, but herein is a subject for reflection, investigation and education. The educational efforts should be directed toward bringing the higher officers of the railroads into a realization of

the importance of records from which the actual cost of work may be obtained, and into a correct way of using the results obtained. It may be said that every mechanical superintendent is fully aware of the saving which would be effected by replacing old, inadequate tools with new ones; but why, then, is it difficult for them to obtain appropriations for new and efficient ones? In answer to this Mr. Forsyth says: "It is the fault of the mechanical officers in not first ascertaining what is the cost of production under existing conditions and what would be the cost under improved conditions." Officers in charge of expenditures were never more ready to save money than they are now, and the explanation offered appears to be the correct one. If business administration of railroad properties is to be the rule, the cost of work must be known, and it must be had in terms which are adapted to the purpose of comparison in order to keep track of improvements.

The usual way of stating the cost of repairs is in terms of engine miles, and until recently this has also been true of statements of fuel records. This does not recognize in any way the amount of work done by the engines, and the results are really worthless for comparisons. Fair comparisons between different roads or upon different divisions of the same road cannot be made without taking many details into consideration, and the suggestion, made in the discussion of the paper referred to, to the effect that comparisons should be made only with previous records upon the same road or division is an excellent one. It is obviously unfair to compare the cost of repairs or of fuel upon the Lake Shore & Michigan Southern with that of the Union Pacific, but there is a tendency to make such comparisons.

The paper referred to is suggestive, and it merits wide attention, because it gets at the foundation of one of the most important matters now before the railroads and one which is intimately related to the management of men in the shops, but with this side of the question the author does not deal. He shows two ways in which the cost of repairs may be reduced. The first is by the introduction of new and efficient machinery, and the other by improvements over old methods. Among the improvements suggested are: Increased capacity of old tools, the use of more efficient new tools and more efficient work on the part of the men. He advocates systematic grinding of tools upon universal grinding machines, the use of the best of tool steel and other factors which tend to keep down the idle time of the machines. The speeding up of belts to 4,000 or 4,500 feet per minute, the speeding up of machines, the use of heavy feeds and quicker return motions, all tend to produce the desired results. The author remarks that enterprising locomotive building concerns have discarded old machinery and installed the best up-to-date equipment in its place and expresses the opinion that the reason why railroads do not follow the same plan is that the repair accounts are buried in a large general operating expense and that they are assumed to be necessarily large and indefinite. To these suggestions might be added one to the effect that the underlying idea of this paper is also the basis for establishing piece-rate systems. The subject should be brought to the attention of managing officers and Mr. Forsyth's method of doing it seems admirable, that is, for the mechanical men to show what they can do with mproved facilities.

MAINTENANCE RULE FOR INTERLOCKING IN ILLINOIS.

One of the most important factors in the safe handling of trains, whether fast ones or not, is the protection of crossings and junction points by interlocking apparatus. The safety of a fast train depends very largely upon the ability to stop in a short distance after the information is given that a stop is necessary, and signal appliances must be looked to to go give the information to the engine runners in season to enable them to make the stop at the proper place. Interlocking signals grow in importance with the increasing demands for fast service, and it is well that more careful attention should be given to this branch of engineering. This is specially true because of the necessity of keeping the apparatus in good condition at all times. Some roads have placed the care of signal apparatus in the hands of specialists. These are called "signal engineers," and very properly, when the men are fitted for their responsibilities, for the reason that the subject demands much study, engineering knowledge and experience for its mastery. These engineers are comparatively few in number and many roads intrust the care of signals to men who are not properly qualified for that important work. It may safely be said that those roads not having qualified engineers in charge of this apparatus are not treating their signaling problems properly. Accidents do not always immediately follow wrong design, faulty construction or careless maintenance of signals, but roads can hardly afford to ignore this matter, and it is appropriate to remind them that public sentiment may prove to be a hard master if they persist in its neglect. It is better that the roads should appreciate the importance of signaling and voluntarily take the necessary steps to put this department, along with that in charge of bridges, in a position to guarantee safety. Good bridges are necessary, and no carelessness or false economy is permitted in connection with them. Good signals well maintained are not less necessary, and yet the fact does not seem to be so generally appreciated.

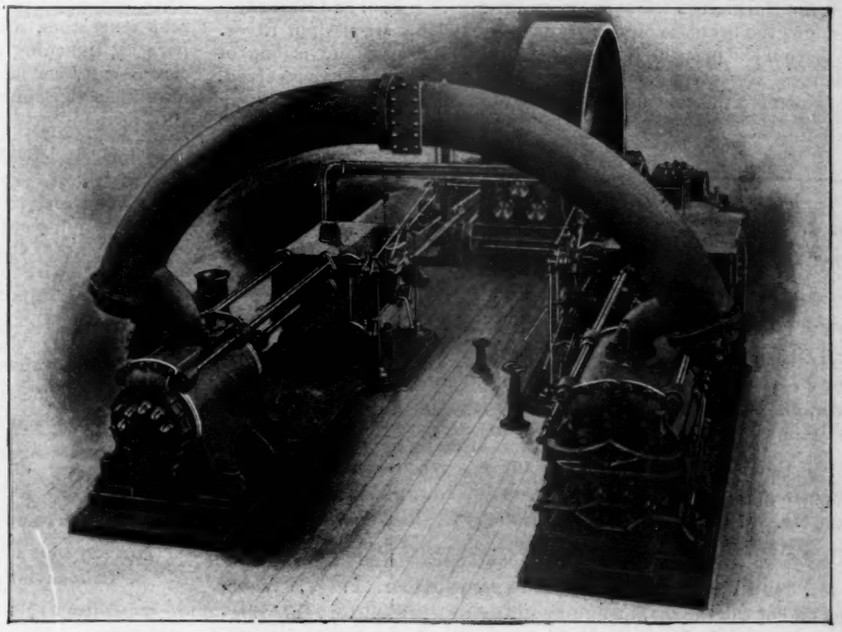
The time is rapidly approaching when railroads will be driven to pay more attention to signals, and it is not altogether impossible that the rigidity of outside inspection will be applied here as it is in England. The roads will not relish this, but they have the remedy at hand, viz., to render such inspection unnecessary by the great care which they themselves give to the apparatus. The new clause which has just been added to the rules governing interlocking in Illinois is a step in the direction spoken of, and it has been found necessary in that State for the Railroad Commission to keep a closer watch of the maintenance of signals. The Railroad and Warehouse Commissioners of Illinois are practically responsible for the safety of interlocking apparatus, although until recently comparatively little attention has been paid to the manner of keeping the plants in repair. The new rule, however, renders it necessary for the railroads to file monthly reports of the condition of every plant with the commission, and blank forms are issued to the roads for this purpose. These reports are to cover the condition of the apparatus and of the crossing frogs, and they require statements of failures of the apparatus, the occurrence of derailments, with their causes, and the dates of inspection and names of inspectors are also to be given, all these to be signed by the officer in charge of the apparatus. In the event of a disagreement in the reports for each plant, and where such disagreement involves the safe operation of the appliances, it becomes the duty of the consulting engineer of the commission to investigate and report his findings to the board.

This is not the only State requiring such reports, Michigan having had a similar regulation in force for a number of years, and the tendency toward external supervision is apparently growing. That some rather sharp criticisms would be offered with regard to the Illinois rule was to be expected, but this only shows that the rule was necessary, because there can be no objection to reporting signal apparatus to be in good condition when it may be so reported and giving the authority for the statements. One decidedly good result is to be expected in the case of those companies desiring to properly maintain these devices who could not force other roads crossing them to give the necessary attention to maintenance. It appears to be necessary to force some railroads to protect themselves, and as long as this condition exists outside pressure should be brought to bear upon them. If it leads eventually to placing the supervision of signaling in the hands of the equivalent to the English "Board of Trade" the railroads have only themselves to blame, and there are very good reasons for believing that the roads will be much better off in respect to safety devices when this is accomplished. An excellent example of government supervision of safety appliances is seen in connection with the inspection of steam vessels. No one now finds fault with this system or thinks it undesirable, and the results of the inspection must be considered as most satisfactory. The equivalent of this should be had on the railroads with respect to signals, and if the roads themselves do not provide it others will.

A Rand Air Compressor—The Largest in Canada.

Under the title "A Large Rand Compressor" we published in our April issue of the current volume a brief description of the compressor recently furnished by The Rand Drill Company, of 100 Broadway, New York, to the Le Roi mine at Rossland, B. C. This is the largest compressor ever put into operation in Canada, and it was built at the Canadian works of the Rand Company at Sherbrooke, P. Q. It is described as a beautiful piece of mechanism by those who saw it standing on the shop floor when it was inspected prior to being shipped to the mine.

On the steam end the engine is of the Corliss type, made in the form of a cross-compound condensing machine. The high-pressure cylinder is 22 inches in diameter by 48 inches stroke, taking steam through a pipe 6 inches in diameter. The low-pressure cylinder on the opposite side of the machine is 40 inches in diameter by 48 inches stroke. Both cylinders are fitted with the Corliss liberating type valve, with vacuum dash pot, and with a sensitive governor operating on the release gear, to be operated automatically from six or eight revolutions to the maximum number of revolutions per minute. The main shaft is 14 inches in diameter by 13 feet long, weighing about 5,500 pounds. The shaft is fitted with cranks pressed on under immense pressure. The connecting rod forgings and piston rod forgings are well and carefully finished.



A Large Air Compressor by The Rand Drill Company.

The air end of the machine is fitted tandem with the steam cylinders and is also compound, the high-pressure air cylinder being 22 inches in diameter by 48 inches stroke. The valve motion supplying these cylinders is Rand's most economical type, being in the form of mechanical valves. By this means the filling of the low-pressure cylinder with air at atmospheric pressure is insured, which fact largely affects the efficiency of the machine, for were the cylinder either not completely filled, or the air hot and expanded, the efficiency would be correspondingly decreased. The inlet valves of the low-pressure or intake air cylinder are surrounded by a hood which is connected to a flue for the introduction of the cold air from out of doors. Between the high and low-pressure cylinders is an intercooler of the latest type. Through this intercooler the air passes over a system of water circulating pipes and is cooled in the process. This compressor engine will be used for running all the pumps and hoists at the mine in addition to operating 40 drills.

Books Received.

POWER-TRANSMISSION APPLIANCES. A catalogue of the Dodge Manufacturing Company, of Mishawaka, Ind,

ANNOUNCEMENT COLLEGE OF ENGINEERING AND THE MECHANIC ARTS OF THE UNIVERSISY OF MINNESOTA FOR 1897-1898.

PURDUE UNIVERSITY—ANNUAL CATALOGUE FOR 1896-1897. The annual catalogue of Purdue University, Lafayette, Indiana.

TENTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. Dec. 1, 1896. Washington: Goverment Printing Office.

ANNUAL REPORT OF THE CITY ENGINEER, CITY OF PROVIDENCE, R. I., FOR THE YEAR 1896. From M. J. Herbert Shedd, City Engineer.

FORTY-SEVENTH ANNUAL REPORT OF THE BOARD OF DIRECTORS OF THE PANAMA RAILROAD COMPANY FOR THE YEAR ENDING DECEMBER 31, 1896.

FOURTEENTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK FOR THE YEAR 1896. Two volumes, 1897. Maps.

SEVENTH ANNUAL REPORT OF THE BOARD OF DIRECTORS OF THE PITTSBURGH, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY COMPANY, TOGETHER WITH ABSTRACTS FROM THE REPORTS OF THE COMPTROLLER AND THE GENERAL MANAGER, FOR THE YEAR ENDING DECEMBER 31, 1896.

THE SYNCHRONOGRAPH. A New Method of Rapidly Transmitting Intelligence by the Alternating Current, by Albert Cushing Crehore, Ph. D., Asst. Professor of Physics, Dartmouth College, and George Owen Squier, Ph. D., First Lieutenant of Artillery, United States Army, and Instructor of Electricity and Mines, U. S. Artillery School. Reprinted from the Proceedings of the American Institute of Electrical Engineers.

THE LOCOMOTIVE—ITS FAILURES AND REMEDIES. By Thomas Pearce. Published by D. Van Nortrand Company. 96 pages. (4¼ by 7 inches in size.)

This little book was written by a locomotive runner on the Great Western Railway of England. Its object was to present the necessary information to candidates for the position of locomotive runners to enable them to pass the examinations which are now commonly held in that country. In an appendix plates are presented for the purpose of instructing in regard to the positions of the cranks, eccentrics and valves in order to make the required tests of the parts. The work is well adapted to the purpose of the writer, the language being direct, plain and easily understood. The subject has received intelligent treatment. It is arranged in the form of questions and answers.

Messrs. John Wiley & Sons announce that a book by Colonel H. S. Haines will soon be brought out by them. The title is "Addresses Delivered Before the American Railway Association." An appendix contains other addresses by Colonel Haines, who was President of the association referred to from 1890 to 1896.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

CATALOGUE OF PRESSES, DROP HAMMERS AND DIES. Designed and built by The Stiles & Fladd Press Company, Watertown, N. Y. 1897. Standard size (6 by 9 inches), 64 pages, illustrated.

This catalogue is of special interest, because of the fact that it represents a single development of a single year, the first machine having been shipped May 1, 1896. It presents the design by this

company of power and foot presses, drop hammers, dies, power shears and special machinery, only those being shown which are considered as standards of the manufacturers. The variety of design is large, and the system followed in their construction admits of using such dimensions for stroke opening in the machine beds and similar features as may be required by the special demands the work to be done by purchasers. The pamphlet is well printed and illustrated.

THE WESTINGHOUSE HIGH-SPEED BRAKE. A DISTINCT ADVANCE IN THE AIR-BRAKE ART. The Westinghouse Air-Brake Company, Pittsburgh, Pa., May 1, 1897; 16 pages, cloth, illustrated; not standard size.

The newly perfected "High-Speed Brake" is fully described and illustrated in this book, which will be read with interest by all who are concerned with the safety of high-speed train service. Space is not available at this time for an adequate notice of the improvement, but attention will be given it in a future issue.

THE FINEST TRAIN IN THE WORLD.

This is an eight-page pamphlet, handsomely illustrated, describing the Burlington trains between Chicago, St. Paul and Minneapolis, and the beauties of the scenery along the Mississippi River. It is from the press of Rogers & Wells, of Chicago, and is one of the most attractive pamphlets of the kind which we have received. It is printed in two colors and the engravings are very fine.

Personals.

De Volson Wood, Professor of Mechanical Engineering, Stevens Institute of Technology, died June 27, aged 65 years.

We are informed that after July 1 Mr. R. D. Wade, late Superintendent Motive Power of the Southern Railway, will act as Southern representative of the Baldwin Locomotive Works.

Mr. Charles W. Dunn has been appointed Inspector of Material and Workmanship of the Brooks Locomotive Works at Dunkirk, N. Y. Mr. Dunn was formerly in the employ of Robert W. Hunt & Company, of Chicago.

It is reported that Mr. R. H. Soule has resigned the position of Superintendent of Motive Power of the Norfolk & Western and that Mr. W. H. Lewis, Master Mechanic of the Chicago, Burlington & Northern, succeeds him July 1.

Mr. John Ramsbottom, the predecessor of Mr. F. W. Webb, and one of the important figures in the railroad history of England, has just died in England. He was born in 1814, and was Locomotive Superintendent of the Manchester & Birmingham, and its successor, the London & North Western, for many years, beginning in 1842. He succeeded Mr. Francis Trevithick at the head of the Crewe works in 1857, and made the large extensions which converted those shops into a city. He was the designer of the Waverley class of locomotives, of which the "Lady of the Lake" was a well-known example. He invented the track tank for delivering water to locomotives in motion, and it was first used on the London & North Western. Mr. Ramsbottom retained the post of Consulting Engineer to the London & North Western down to the time of his death, and was President of the Institution of Mechanical Engineers.

Mr. Frank H. Soule, General Car Inspector of the N. Y., N. H. & H. R. R., died in New Haven, Conn., May 28, after a brief illness.

Entering railroad service at the age of 17 years, he began in the shops of the old Boston, Hartford & Erie Railroad, at Readville, Mass, afterward controlled by the New England Railroad. He advanced rapidly and was soon made assistant to Mr. Marden, Superintendent of Car Department of the Fitchburg Railroad. Subsequently he became General Inspector of the Fast Freight Line between Boston and Chicago, where he served several years, after which he went to the Lake Shore & Michigan Southern Railroad as General Car Inspector, whence he came two and a half years ago to the New York, New Haven & Hartford Railroad in the same capacity. Mr. Soule was most favorably and widely known by railroad men throughout the country. His thorough knowledge, quick perception and absolute fairness in all that pertained to matters of car interchange won for him the respect and regard of his associates in the railroad world. He will be missed in the Master Car Builders' conventions, where his good judgment and wise counsel has done much toward bettering the conditions surrounding the inspection and interchange of car equipment, and his untimely death will be regretted by all who knew him.

National Electric Light Asssociation Convention.

The twentieth annual convention of the National Electric Light Association held at Niagara Falls, on the 8th, 9th and 10th of June, was considered by the delegates to be one of the most successful gatherings in the history of that organization. A number of very interesting papers were read and discussed. The attendance was unusually large and the exhibitions of electrical apparatus made by the different supply houses throughout the country was of more than ordinary completeness. The exhibit of the Westinghouse Electric and Manufacturing Company was especially attractive owing to its completeness and the many interesting features it contained. This company had on display several induction motors, direct current generators, alternating current generaters, switchboard apparatus, lightning arresters, converters, arc lamps and incandescent lamps, the latter forming an exhibit made by the Sawyer Man Electric Company, of Allegheny City, Pa.

Metallic Brake Beam Litigation.

We have received the following communication from the Chicago Railway Equipment Company concerning the status of reports of infringements of the National Hollow Brake Beam Company's patents. We desire to advise you that this company has instituted the following suits to determine its rights under its patents:

IN THE UNITED STATES CIRCUIT COURT AT ST. LOUIS, MO.

National Hollow Brake Beam Company and Chicago Railway Equipment Company, vs. Interchangeable Brake Beam Company. — In Equity No. 4047.

Chicago Railway Equipment Company, vs. Interchangeable Brake Beam Company. — In Equity No. 4048.

IN THE UNITED STATES CIRCUIT COURT AT SPRINGFIELD, ILL.

National Hollow Brake Beam Company and Chicago Railway Equipment Company, vs. Missouri Malleable Iron Company. — In Equity No. 8414.

Chicago Railway Equipment Company, vs. Missouri Malleable Iron Company. — In Equity No. 8415.

These suits—four in all—and in two different circuits, will, when finally decided, determine the question of infringement of the patents, and the liability of maker, seller and user of all brake beams of like construction to the one offered by us. We shall use every effort to bring the suits to a conclusion at as early date as possible.

CHICAGO RAILWAY EQUIPMENT COMPANY,
E. B. Leigh, General Manager.

EQUIPMENT AND MANUFACTURING NOTES.

The Pennsylvania Railroad is about to build five freight engines in its own shops.

The Richmond Locomotive Works will build 10 locomotives for the Southern Railway.

The Great Northern has ordered 15 19 by 26-inch moguls from the Brooks Locomotive Works.

The Baltimore & Ohio Railroad has ordered 15 locomotives of the Pittsburgh Locomotive Works.

The Jackson & Sharp Company has just finished 12 cars for the Norfolk, Virginia Beach & Southern.

The Allison Manufacturing Company has an order for 100 cars from the Westmoreland Coal Company.

The B. & O. Southwestern has ordered 200 freight cars of the Ohio Falls Car Manufacturing Company.

The Dickson Manufacturing Company is building a locomotive for the Buffalo & Susquehanna Railroad.

The Buffalo, Rochester & Pittsburgh has ordered 200 freight cars of the Buffalo Car Manufacturing Company.

The Baldwin Locomotive Works will build 18 16 by 24-inch American type locomotives for the Japanese government.

The Boston & Maine has ordered six passenger engines with 19 by 24-inch cylinders of the Manchester Locomotive Works.

The Mexico, Cuernavaca & Pacific has ordered 50 box and 2 caboose cars from the Missouri Car and Foundry Company, of St. Louis.

The Ashton safety valves, Nathan lubricators and Hancock inspirators will be used on the locomotives recently ordered by the Boston & Maine Railroad.

H K. Porter & Company, Pittsburgh, Pa., are reported to have recently received an order from the Russian government for light locomotives for use in Finland.

The Baldwin Locomotive Works will alter 15 simple locomotives for the Erie to the Vauclain compound system. This brings the number so converted during the year to 43.

Efforts are being made by the Philadelphia & Reading Railroad Company to establish a direct steamship service between Philadelphia and the United Kingdom and the continent of Europe.

It is reported that the Gould Coupler Company, Buffalo, N. Y., will erect a plant at Brantford, Ont., to manufacture its devices for the Canadian trade. It may make use of the Grand Trunk shops, which are about to be vacated.

Announcement was made June 23 of the consolidation of the Pennsylvania Iron Works of Philadelphia with the Siemens-Halske Electrical Construction Company of Chicago. The result will be the strongest street railway equipment concern in the country.

The Ashton Pop Safety Valves have been selected for use on the new experimental locomotive which is under construction at the Schenectady Locomotive Works for Purdue University. These valves will control the high pressure of 250 pounds per square inch, the maximum to be used on the locomotive.

We are advised by Mr. William S. McGowan, Jr., Treasurer of the Hancock Inspirator Company, that that company has purchased the patents and the entire business of the Park Injector Company, of Boston and Whitman, Mass. All persons requiring information and prices of the Park injectors may obtain them from the Hancock Inspirator Company, of Boston, Mass.

Mr. W. B. Mack announces that the Mack Injector Company, of 35 Congress Street, Boston, is prepared to sell the "Torpedo" and other injectors, formerly manufactured by the National Tube Works Company. Mr. Mack was active at the recent conventions in the interest of this line of supplies, and exhibited drawings of the "Torpedo" injector in three classes, A, B and C.

The Ashton Valve Company, of 271 Franklin Street, Boston, has continued to do a good business through the financial depression. Among the locomotives now being built upon which the Ashton pop valves are to be used are a number for the following roads: The Boston & Maine, the Rio Grande Western and the Houston & Texas Central.

The Peerless Rubber Manufacturing Company has just issued a new circular describing its chief specialties, such as "Rainbow," "Honest John," "Hercules" and "Peerless" packings. This will interest readers who desire information pertaining to packing. The best "compliment" paid to a manufacturer is to imitate his product, and this has been done with the "Rainbow" packing, which is unquestionably the best packing available for the purposes to which it is adapted.

Among the other orders recently received by the Schenectady Locomotive Works is one for eight 10-wheel compound freight locomotives, having cylinders 22 and 34 by 26 inches, for the Northern Pacific Railroad. (These engines are duplicate of two of the same class built for the Northern Pacific, by the Schenectady Works, last March;) five 10-wheel freight engines, cylinders 18 by 24 inches, for the Florida East Coast Line; two 8-wheel passenger engines, cylinders 18 by 24 inches, for the Detroit, Grand Rapids & Western, and two 6-wheel switching locomotives, cylinders, 19 by 24 inches for the Houston & Texas Central.

The Schnectady Locomotive Works has received an order for 12 narrow-gage passenger locomotives for the Kiushiu Railway Company of Japan. The general design is of the American type, with cylinders 16 inches diameter and 24 inches stroke, and the driving wheels are 56 inches diameter. The tenders have six wheels, the general design being similar to that used on the railroads of England. The locomotives are to be built to run on 3-feet 6-inch track, that being the standard gage of the railroads of Japan. On completion, each locomotive will be tested under steam on a temporary track at the works, and after inspection will be taken apart and packed for loading on steamship at New York.

Among the exhibits at the conventions was one of the Vim special air-brake hose by the Boston Woven Hose and Rubber Company, of 275 Devonshire street, Boston, Mass. This hose consists of a heavy rubber inner tube surrounded by a seamless woven tube of cotton, which is again surrounded by a rubber tube and over this is another of seamless cotton. The whole is then enveloped in an outside rubber tube. The product is a strong pliable hose with the elements in close contact, the object of the construction being to insure strength together with the necessary provisions against kinking. The same plan is followed in making steam hose, but the inner tube is then made of rubber which is specially selected for resisting the effects of the steam. This type of hose is claimed to be the equivalent in strength to what is ordinarily termed four-ply hose.

Our Directory

OF OFFICIAL CHANGES IN JUNE.

Canadian Pacific.—Mr. W. Cross has been appointed Master Mechanic of all Canadian Pacific lines west of Fort Williams, with headquarters at Winnipeg.

Columbus, Sandusky & Hocking.—Mr. Samuel M. Felton, President and Receiver of the Cincinnati, New Orleans & Texas Pacific, was, on June 2, appointed Receiver of the Columbus, Sandusky & Hocking.

Fort Wayne, Terra Haute & Southwestern.—Mr. Frank P. Welsh has resigned as Receiver, and has been succeeded by Mr. Frank L. Winsor, with headquarters at Rock Island, Ill.

Fort Wayne & Rio Grande.—Mr. H. D. Galbraith has resigned as Master Mechanic, and Mr. B. G. Plummer has been appointed Master Mechanic, with headquarters at Fort Worth, Tex.

Grand Trunk.—Mr. J. A. Slack has resigned the position of Assistant Master Mechanic at Butte Creek, Mich., and the office has been abolished.

Harriman & Northeastern.—Mr. George W. Chandler, General Manager, was on May 20 appointed Receiver of that road.

International & Great Northern.—Mr. E. C. Manson, Superintendent Car Service, and Mr. W. E. Williams, Purchasing Agent, have retired, and their duties will be performed by General Superintendent Noble, at Palestine, Tex. Mr. T. M. Campbell has resigned as General Manager. He has held the position since 1892. Mr. Leroy Trice has been appointed General Superintendent. Geo. L. Noble was on May 25, 1897, appointed Assistant General Superintendent, vice E. O. Griffin, previously General Manager's Assistant.

Lehigh Valley.—Mr. J. Campbell, Master Mechanic at Buffalo, has had his jurisdiction extended over the car department at that point.

Louisville & Nashville.—Mr. Charles E. Slade, formerly Master Mechanic of the Louisville & Nashville, died at New Orleans, La., a few days ago.

Mexican Southeastern.—Mr. W. A. M. Lennan, of Montreal, has been appointed General Purchasing Agent, with headquarters in Cleveland, O.

Minneapolis & St. Louis.—Mr. L. L. Day, formerly Chairman of the Southwestern Traffic Association, has been appointed General Manager, with headquarters at Minneapolis, Minn.

Monterey & Mexican Gulf.—Mr. A. Mounom, General Manager, has resigned, and will be succeeded by Mr. J. H. Mathey, of Brussels, Belgium.

New Jersey & New York Railroad.—Mr. Geo. M. Cumming has been elected first Vice-President of this company, with office at No. 21 Cortlandt Street, New York.

Pittsburgh, Bessemer & Lake Erie.—Mr. J. L. Blim has resigned as General Manager and was appointed General Agent of that company.

Plant System.—Mr. Frank I. Brown, of Boston, has been elected Third Vice-President, in place of Mr. D. F. Jack, resigned. Mr. Brown is also President of the Florida Southern Railway.

San Diego, Cuyamaca & Eastern Railway.—Mr. Heber Ingle has been elected President, and Mr. Levi Chase Vice-President of this company.

Sedalia, Marshall & Miami.—Mr. J. E. House, of Omaha, has been appointed Chief Engineer of this proposed line, and is now preparing for the survey.

South Carolina & Georgia.—Mr. Joseph H. Lunds, formerly General Manager of the Norfolk & Western, has been appointed General Manager of this road, with headquarters at Charleston, S. C. He takes the place of Mr. E. S. Bowen, who is reported to have resigned on account of ill health.

South Shore Railway.—F. X. Choquet has been elected President, with office at Montreal, Que.

Wabash.—Mr. Richard Purcell, formerly Division Superintendent and Master Mechanic of the Wabash, died at Quincy, Ill., May 21, aged 80 years.

Williamsport & North Branch.—The resignation of Mr. H. C. McCormick as President of the Williamsport & North Branch was accepted at the annual meeting June 4. The other officers were re-elected.

Exhibits at the Conventions.

The following is a complete list of the exhibits at the Master Car Builders and Master Mechanics' Conventions:

Acme Machinery Company, Cleveland, O.; double bolt cutter, with Fergusson's air-operated turrets. Represented by A. H. Carpenter.

Adams & Westlake Company, Chicago; car fixtures.

Ajax Metal Company, Philadelphia, Pa.

American Brake Beam Company, Chicago.

American Steel Casting Company, Thurlow, Pa.

American Steel Foundry Company, St. Louis.

Ashton Valve Company, Boston, Mass.

Automatic Air and Steam Coupler Company, St. Louis; air and steam coupler in operation.

Automatic Lubricator Company, Rochester, N. Y.

Bettendorf Axle Company, Davenport, Ia.; Bettendorf brake-beam complete and parts for assembling.

B. E. Tilden Company, Chicago.

Boston Belting Company, Boston; full line of mechanical rubber supplies.

Boston Woven Hose and Rubber Company, Boston; air brake and steam hose and railroad rubber goods. Represented by J. O. De Wolf and A. L. Whipple.

Bosley, The D. W. Company, Chicago.

Brown & Sharp, Providence, R. I.

Buckeye Malleable Iron and Coupler Company, Columbus, O.

Brill, J. G. Company, Philadelphia; model of Brill truck.

Baker Forge Company, Ellwood City, Pa.; brake rod and other forgings.

Bushnell Manufacturing Company, Easton, Pa.

Chicago Grain Door Company, Chicago, Ill.

Chicago Pneumatic Tool Company, Chicago; pneumatic piston drills, Boyer pneumatic hammers, flue welder, speed recorder in operation, pneumatic riveter, Manning sand papering machine.

Chicago Railway Equipment Company, Chicago; National hollow brake beam and automatic frictionless side-bearing.

Cloud Steel Truck Company, Chicago; freight car showing the Cloud tender truck with elliptic springs, and freight truck with coil springs, also truck frame and Bettendorf I beam truck and body bolsters.

Composite Brake Shoe Company, Boston; composite brakeshoe with cork inserts.

Cook Cooler Company, Flint, Mich.; the Cook journal cooler.

Crosby Steam Gage Company, Boston.

Curtis & Company Manufacturing Company, St. Louis; 8 × 8 steam-driven air compressor, in operation, 6×6 belt-driven air compressors.

Detroit Lubricator Company, Detroit, Mich., improved triple locomotive lubricator.

Detrick & Harvey Machine Company, Baltimore, Md.

Dressel Railway Lamp Works, New York; lamps.

Edgar Sebring Car Seal and Lock Company, Colorado Springs, Col.

Erie Malleable Iron Company, Erie, Pa.; the Erie coupler.

Fairbanks, Morse & Company, Chicago; three horse-power combined gasoline pumping engine in operation, Barrett car jack, Sheffield hand car wheel, model of Sheffield hand car.

Franklin Steel Castings Company, Franklin, Pa.; the Lone Star coupler.

F. W. Bird & Son, East Walope, Mass.; torsion proof car roof and Neponset insulating paper.

Gould Coupler Company, New York; the new Gould freight coupler, friction uncoupling device, spring freight car buffers, Gould passenger coupler for express cars without platforms.

Goodwin Car Company, Chicago; full sized dumping car on the grounds and model in exhibition room.

Gravity Car Coupling Company, Colorado Springs, Colo.; models of Gravity coupler.

Gold Car Heating Company, New York and Chicago; steam heating system, full size, under steam, and full line of electric heaters.

Hancock Inspirator Company, Boston; the Hancock inspirator, boiler checks, ejector and hose strainer.

Hale & Kilburn Manufacturing Company, Philadelphia, Pa.; new "Walkover" seat with movable foot rest and oval pedestal base, and "Reversible" car seat with new base and foot rest.

Hinson Manufacturing Company, Chicago; refacing pin.

H. W. Johns Manufacturing Company, New York; asbestos, vulcabeston, boiler and pipe coverings, packing, etc.

H. H. Hewett, Buffalo; model of the Hewett rolled steel truck.

Interchangeable Brake Beam Company, St. Louis; the interchangeable brake beam.

Jenkins Bros., New York; the Jenkins valves.

Joyce, Cridland & Company, Dayton; geared lever jack.

John R. Jones, Philadelphia; model of steel car wheel rolling machine.

Keasbey Matteson Company, Ambler, Pa.; magnesia covering for boilers and pipes.

Kinzer & Jones Manufacturing Company, Pittsburg, Pa.; Kinzer brake shoe.

Knitted Mattress Company, Canton Junction, Mass.

Leach Locomotive Sander, Boston; locomotive sander.

McCord & Company, Chicago; the McCord journal box and lid.

Main Belting Company, Philadelphia; Leviathan belting in various sizes from 90 inches in width down.

Marion Car Coupler Company, Marion, O.; the Murphy automatic car coupler.

Marion Car Coupler Company, Marion, O.; the Murphy automatic car coupler.

Mason Regulator Company, Boston; locomotive reducing valves pump governors, boiler feed pumps, airbrake regulators and damper regulators.

Michigan Malleable Iron Company, Detroit; the Detroit coupler, Thornburgh coupler attachment.

Missouri Malleable Iron Company, St. Louis; refined malleable castings for railways.

Monarch Brake Beam Company, Detroit; Monarch brakebeams.

Moran Flexible Steam Joint Company, Louisville, Ky., joints under steam and air pressure, all sizes.

McConley & Torley Company, Pittsburgh, Pa.; Janney Coupler and new locking attachment.

Mr. Hyde, Philadelphia; improved journal box.

National Car Coupler Company, Chicago; national buffer, national miller combination, national freight car coupler.

National Malleable Castings Company, Cleveland; Tower coupler, oil boxes, bolsters, journal box lids, carlin pockets, uncoupling hose attachments, door fastenings and other specialties.

National Railway Specialty Company, Chicago; security door.

New York Belting & Packing Co., New York; steam and air brake hose and interlocking rubber tiling.

New York Rail Insulation & Equipment Company, Newark, N. J.

Norton, A. O., Boston; Norton's improved ball-bearing ratchet screw jacks.

Niles Tool Works Company, Hamilton, O.

P. H. Murphy Manufacturing Company, St. Louis; Murphy improved Winslow car roof.

Pantasote Leather Company, New York; car curtains, car seats and car headlinings.

Pearson Jack Company, New York; car replacing jack.

Peerless Car Coupler Company, New York; Peerless couplers.

Peerless Rubber Manufacturing Company, New York; full line of mechanical goods, including the famous Rainbaw packing.

Pencoyd Iron Works, Pencoyd, Pa.; car and engine axles.

Pratt & Letchworth, Buffalo; malleable iron car castings, steel castings for locomotives and cars, automatic freight car coupler.

The Pyle National Electric Headlight Company, Chicago.

Q & C Company, Chicago; McKee brake slack adjuster and Hoyt flush door.

Rand Drill Company, New York and Chicago; duplex belt driven air compressor furnishing air for Chicago Pneumatic Tool Company.

Railroad Supply Company, Chicago; Hein double automatic car coupler, Universal release rig journal box lifter.

Revere Rubber Company, of Boston; full line of railway rubber goods.

Richmond Locomotive and Machine Works.

Safety Car Heating and Lighting Company, New York City.

Safety Car Coupling, Philadelphia.

Sams Automatic Car Coupler Company, Denver, Col.; the Sams coupler.

Schoen Pressed Steel Company, Pittsburgh, Pa.; steel cars and trucks.

Shelby Steel Tube Company, Shelby, O.; boiler flues.

Silvius & Company, E. T., Indianapolis Ind.; improved journal box for engine trucks.

Sherry Torch Company, Rochester, N. Y.

Simplex Railway Appliance Company, Chicago; Simplex steel and malleable iron bolster.

Standard Paint Company, New York; sample of Ruberoid roofing.

Sterlingworth Railway Supply Company, New York; brake beams.

Shickle, Harrison & Howard Iron Company, St. Louis, one diamond-shaped truck, with steel frame and bolster.

S. T. Cummings, Del Rio, Tex.; locomotive ash pan.

Standard Coupler Company; standard steel passenger platform buffing mechanism and coupler.

The Babcock Tire-Trimming Company, Johnsonburg, Pa.; the Babcock tire trimmer.

The Railroad Signal Lamp and Lantern Company, New York.

The Sinclair-Scott Company, Baltimore, Md.; the Royal Flush car door.

The Smillie Coupler Company, Newark, N. J.; the Smillie coupler

Star Brass Company, Boston; locomotive pop valves, steam gauges and locomotive appliances.

Toledo Railway Appliance Company; gravity air brake dust guard.

Watson & Stillman, New York; crank pin press, girder rail bender, rail punches, piston-rod jack, hydraulic jacks.

Webster Manufacturing Company, Chicago; gas engine operating Rand drill for Chicago Pneumatic Tool Company.

Western Railway Equipment Company, St. Louis; Houston pneumatic sander, St. Louis single track flush car door, economy slack adjuster, combination lug and follower casting, Missouri draft attachment, safety truck end casting.

Wilmington Malleable Iron Company; Wilmington, Del.

Yerdon William, Fort Plain, N. Y.; improved double hose-band.

Complements of the Conventions.

The surroundings of Fortress Monroe are most admirably adapted to render the place an interesting one for the conventions. The scientific work which is going on at the fort is itself worth a trip to investigate, as this is one of the most important of the artillery stations of the United States Army and a great deal of interesting investigation is conducted there with reference to projectiles and their flights. Through the efforts of the officers of the Richmond Locomotive Works the members of the associations and their friends were enabled to inspect the battleship *Texas* which was ordered to Old Point Comfort for the purpose. This ship was particularly interesting because the machinery was built by the concern mentioned.

The other attractions of the neighborhood were the Newport News shipyards and the Norfolk Navy Yard, to both of which the members were invited. The Richmond Locomotive Works were visited by the members and guests in a body, by courtesy of the officers of the works and the Chesapeake & Ohio Railroad, and the trip was a profitable one. It would probably be impossible to select a place for the conventions where more opportunities would be offered for profitable visits to manufacturing plants unless the conventions were held in a large city. Among the pleasant excursions were two by water, one being provided by Mr. W. S. Morris, of the Chesapeake & Ohio Railroad, and the other by Mr. E. St. John, Vice-President and General Manager, and Mr. W. T. Reed, Superintendent of Motive Power of the Seaboard Air Line. The latter trip gave an opportunity for a number of railroad men to inspect the terminal facilities of the Seaboard Air Line in Norfolk and Portsmouth. The terminal tug *Dorothea* was tendered for the occasion, in charge of Capt. George W. Mansfield, and the excellent appointments of the boat and the neatness of everything on board occasioned many favorable comments and contributed to the enjoyment of the party. The exhibits this year were instructive, and among the most noteworthy were the metallic cars, considerable advance having been made during the year in this field. The Schoen pressed steel cars built by the Schoen Pressed Steel Co., constituted one of the most interesting of the exhibits.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS AND SUMMARIES OF REPORTS PRESENTED AT THE THIRTY-FIRST ANNUAL CONVENTION.

Specifications and Guarantee for Cast-Iron Wheels.

J. N. Barr, S. P. Bush, John Hodge, J. H. McConnell, Wm. McWood, committee.

No radical change in the specifications is recommended.

Section 1 is made somewhat more definite and the variation allowed in the diameter of the same chill is reduced from $\frac{1}{16}$ to $\frac{1}{32}$ of an inch.

Sec. 2 is modified by the addition of the words "swollen rims."

Sec. 3 is modified by increasing the maximum allowable depth of white iron on the tread from $\frac{7}{8}$ to 1 inch and increasing the minimum in the throat from $\frac{3}{16}$ to $\frac{1}{4}$ inch. It is believed that these changes are desirable and can be readily complied with.

Sec. 4 is changed by adding the thermal test, which consists in heating the tread of the wheel with molten metal. It is universally conceded that in almost all cases of wheels broken in pieces the cause is rapid heating of the rim from application of the brakes, and the proposed test reproduces such circumstances more perfectly than any other tests which have been suggested. The only question with reference to this test is whether the test as proposed is not so severe that in order to meet it the wheel-makers may be compelled to use materials which will seriously impair the durability of the wheel. The testimony on the subject, however, is of such a character as to induce your committee to recommend this test. [See closing paragraph of this report for this test.]

Sec. 5 and Sec. 6 have not been changed.

Sec. 7 has been altered so as to call for the use of the M. C. B. limit gage for flanges.

Sec. 8 is practically unchanged, except that the name of the maker and place of manufacture is called for.

Sec. 9 is a new section and is simply called for to complete the proper applications of the specification.

Your committee is of the opinion that the guarantee adopted in 1893 has never been put in practical operation, and is inclined to think that in some of its requirements it is impractical. After securing proper strength, which is effected by the general specifications, the most important consideration to a railroad company is that of mileage. Our specifications are quite full on the matter of strength, but strength to a great extent varies inversely as durability. Setting aside cases of breakage arising from allowing wheels to run until the flange is worn too thin or the tread too much worn, the breakage of wheels seems to be caused almost exclusively by rapid expansion of the rim due to severe application of the brakes. From this point of view the strength of the wheel is increased:

1. By the use of soft tough iron;
2. By doctoring mixture with ferro-manganese;
3. By reducing the amount of scrap;
4. By softening the mixture and thus reducing the depth of white or chilled iron on the tread;
5. By methods of manufacture.

The durability of the wheel is increased:

1. By the use of hard, brittle irons;
2. By avoiding the use of ferro-manganese;
3. By reducing the amount of scrap;
4. By hardening the mixture and thus increasing the depth of white or chilled iron in the tread;
5. By methods of manufrcture.

It will be seen by the above that items 1, 2 and 4, which tend to increase the strength of the wheel, are diametrically opposite to items 1, 2 and 4, which go to increase the durability of the wheel. It is a difficult matter for railroad officials to go into the minute details of wheel manufacture. A test for strength is of service, but is not sufficient to determine the actual value of wheels when that value depends so much upon the durability of the wheel as well as its strength.

An ideal specification for wheels would be as follows:

1. The chill test must show the mixture chilling $\frac{7}{8}$ inch deep.
2. The chill on the tread of the wheel must be within $\frac{1}{16}$ inch as deep as on the chill test, and must be uniform in depth around the tread.
3. The chill in the throat must be within $\frac{1}{16}$ inch as deep as on the tread.
4. Wheels of the same nominal diameter must not vary more than $\frac{1}{8}$ inch above or below the mean size measured on the circumference.
5. Wheels must be perfectly cylindrical.
6. The tread of the wheel must be perfectly smooth and free from wrinkles, sweat or defects of any kind.
7. The body of the wheel must be free from any defects incident to general foundry work.
8. Wheels must stand a strength test as specified.

A glance at our present specifications shows how far short of these conditions the average wheel falls. It can be stated as a fact that the mileage of the best average wheels is nearly twice as great as the average of the poorer wheels. This is most important for railroad officials to consider. They are not in position to watch the details of manufacture or the materials used, or to determine by an inspection of a few wheels how much wheel service they loose by wheels falling short of the best that can be done in material, strength, chill, etc. If now railroad officials should purchase mileage instead of wheels they would get just what they pay for, and if one wheel-maker should furnish 200,000 miles of wheel mileage for less money than another, there would be no uncertainty in the contract, as there is when wheels are bought for, say, $5, when $6 wheels may furnish $10 worth of mileage as compared with the $5 wheels.

TEST OF C., M. & ST. P. RY. CO. WHEELS MADE UNDER THE 100 POUND WEIGHT, DROPPING 7 FEET CLOSE TO RIM.

"Heavy Pattern."

No. of Wheel.	Date cast.	Chill Test.	Chill.		No. of blows.	Defects.	Weight of wheel.
			Tread.	Throat.			Lbs.
97,060	1, 7, 96	16	12-8	11-10	63	Breakdown	580
98,469	1, 25, 96	16	12-11	10-9	64	Sand wash.	"
98,642	1, 29, 96	16	11-10	9 8	160	Swelled flange.	"
99,769	2, 15, 96	17	12 12	10-9	153	Breakdown.	"
265	2, 25, 96	16	8-7	6-5	152	"	"
713	3, 4, 96	16	10-9	8-7	102	Swelled flange.	"
4,810	5, 14, 96	16	10-9	8-7	84	Breakdown.	"
4,914	5, 18, 96	16	14-12	10-10	99	"	"
5,643	5, 28, 96	16	11-10	9-8	44	"	"
5,972	6, 4, 96	16	10-9	8-7	67	"	"
7,200	6, 25, 96	16	13-12	11 10	56	"	"
7,480	6, 30, 96	16	8-7	6-5	35	Light plate.	"
9,549	8, 6, 96	16	10-9	8 7	64	Breakoown.	"
10,444	8, 22, 96	16	10-9	8-7	84	Swelled rim.	"
10,900	8, 31, 96	16	10 9	8-7	42	Breakdown.	"
15,563	11, 16, 96	16	10-9	8-7	200	"	"
Average blows					91¼		

TEST OF C., M. & ST. P. RY. CO. WHEELS MADE UNDER THE 100 POUND WEIGHT, DROPPING 7 FEET CLOSE TO RIM OF WHEEL.

"Light Pattern."

No. of wheel.	Date cast.	Chill test.	Chill.		No. of blows.	Defects.	Weight of wheel.
			Tread.	Throat.			
3,400	4, 20, 96	16	5-8	6-5	91	Light plate	554
3,676	4, 23, 96	16	12-10	9-8	36	"	"
7,830	7, 7, 96	16	12-11	10-9	22	Breakdown	"
9,134	7, 29, 96	15	12-10	9-8	78	"	"
10,408	8, 22, 96	16	12-11	10-9	46	Swelled rim	"
12,695	10, 1, 96	16	12-11	11-10	65	Breakdown	"
15,690	11, 18, 96	16	13-12	10 10	47	Light flange	"
16,327	11, 30, 96	16	10-9	8-7	85	Breakdown	"
Average blows					58¾		

The average service of a fair ordinary chilled wheel is between seven and eight years, and in many cases this average is increased to twelve or fourteen years. The futility of a four or five year guarantee can be readily seen from the above.

In the matter of weight of wheels, your committee has received various recommendations showing a wide range of opinion as to what is the proper weight. For instance, for 60,000-pound cars the recommendations run from 540 pounds to 700 pounds. It is the opinion of your committee that with fair material a 580-pound wheel is perfectly safe for 60,000-pound cars, and in view of the fact that the lighter cars are rapidly disappearing, it is recommended that wheels less than 550 pounds should not be cast.

The tables attached show the number of blows required to break a piece out of the wheel, the drop weighing 100 pounds and falling 7 feet, the test having been made on one lot of wheels denominated "light pattern," which weighed 550 pounds, the other test being made on a lot of wheels denominated "heavy pattern," which weighed 580 pounds. It will be seen that the average number of blows necessary to break a piece out of the light, or 550-pound pattern, was 58; with the 580-pound pattern the number of blows required to break a piece out was 91. This shows a very great increase in strength produced by the addition of an average of 26 pounds to the weight of the wheel as revealed by the drop test, and it would seem to indicate that if the 550-pound wheels gave satisfactory service under 40,000-pound cars and lighter, that the increase in strength in 580-pound wheels more than meets the increased requirements of service under 60,000-pound cars. Your committee is not able to give any comparisons at present so far as the thermal test is concerned.

The question of the shape of wheel is so indefinite that your committee hesitates to make any special recommendations in the matter of the shape of wheel.

[The thermal test above referred to is as follows: The wheel must be laid flange down in the sand, and a channel way 1¼ inches wide and 4 inches deep, must be molded with green sand around the wheel. The clean tread of the wheel must form one side of this channel way, and the clean flange must form as much of the bottom as its width will cover. The channel way must then be filled to the top with molten cast iron, which must be hot enough when poured, so that the ring which is formed, when the metal is cold, shall be solid or free from wrinkles or layers. The time when the pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plate extends through the tread in either of the wheels tested, the 100 wheels represented by the tests will be rejected.]

Arch Bars and Column Bolts for Diamond Trucks.

E. D. NELSON, GEORGE GIBBS, J. E. SIMONS, T. LYON and J. H. RANKIN, committee.

The principal variables which affect the cross-section of the arch-bars are:

1. The wheel-base of the truck.
2. The vertical distance between arch bars in the center portion of the side frame of the truck.
3. The location of the point of junction of the top and bottom arch bars vertically; that is, making the set equal, or making the bottom arch bar with more set, and the top arch bar with less set, or the reverse.
4. The distance between centers of the column bolts.

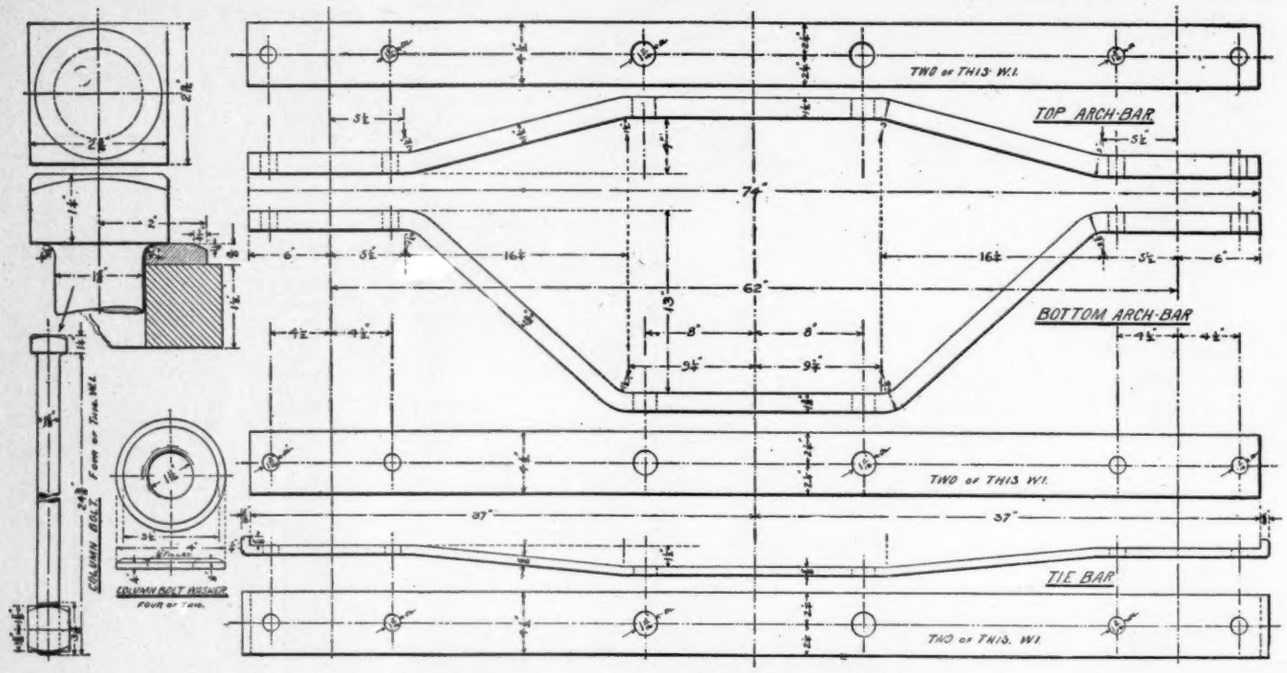
These variables make it desirable to group the trucks within certain limits, because it is necessary to have different sections of arch bars in different designs of trucks, depending on the variables mentioned.

Taking the results obtained by means of the analysis referred to, your committee would recommend for cars of 60,000 pounds capacity the dimensions of arch bars and column bolts as shown in the following table:

Wheel base.	Distance between top and bottom arch bars at column bolts.	Cross-section of bars.			Diam. of column bolt.
		Top arch bar.	Bottom arch bar.	Tie bar.	
	Inches.	Inches.	Inches.	Inches.	Inches.
Greater than 5 feet and not more than 5 feet 6 inches...	14½ to 16½	1⅜ by ¼	1¼ by ¼	⅛ by ¼	1⅜
	16½ and greater	1¼ by ¼	1⅜ by ¼	½ by ¼	1⅝
5 feet.....	14½ to 16½	1¼ by ¼	1⅛ by ¼	⅛ by ¼	1⅜
	16½ and greater	1⅛ by ¼	1 by ¼	½ by ¼	1⅜
Less than 5 feet...	14½ to 16½	1⅛ by ¼	1 by ¼	½ by ¼	1⅜
	16½ and greater	1 by ¼	⅞ by ¼	½ by ¼	1⅜

The diameter of the column bolt shown is that when four are used per truck, two through each arch bar. The diameter of 1⅜ inches may seem somewhat large, but it was thought better than using a smaller diameter in order to provide for wear in certain classes of truck.

In recommending these sizes, it is assumed that material of good quality is used. Wrought iron or steel having a tensile strength of 50,000 to 55,000 pounds per square inch, and an elongation of 20 per cent. on a section originally two inches long, would satisfactorily fill the requirements. Material having a tensile strength of less than 48,000 or more than 60,000 pounds per square inch, or showing less than 15 per cent. elongaton on a section originally two inches long, or if the test piece shows a granular fracture covering more than 50 per cent. of the fractured surface, should not be used. The material should also be free from cracks or fractures when bent to the required forms.



Arch Bars for Diamond Trucks, 80,000 Pounds Capacity.

Your committee does not find it possible, as it hoped might be done, to recommend any standard design, showing amount of set, etc., for arch bars in trucks of 60,000-pound cars.

For a truck to carry cars of 80,000 pounds capacity, your committee would recommend for the top arch bars a section 1¾ by 4½ inches, and for bottom arch bars 1⅝ by 4½ inches; tie bars ⅝ by 4½ inches.

The arch bars and design of same are shown in accompanying drawing. The box for which the bars are designed is the same as that adopted for recommended practice by the association on recommendation of a committee reporting to the convention of 1896.

Automatic Couplers.

C. M. MENDENHALL, A. E. MITCHELL, W. GARSTANG, W. H. THOMAS, T. G. DUNCAN, J. M. MACBETH and J. T. CHAMBERLAIN, committee.

After mentioning the deviations which had been made from the standard design the following recommendations were made:

(1) That the design of the M. C. B. coupler shank, adopted as standard in 1893, be continued without change as the standard of the association.

It is considered impracticable to drill the rivet holes through

coupler shanks; and on account of the variations due to cored holes we think the lips on the ends of straps should remain, but to insure an easy bend there should be added a dimension showing radius of ¼ inch on inside at back corners. The committee would therefore recommend:

(2) That the design of pocket strap included in the recommended practices of the association and shown in Sheet B of Proceedings for 1896, with a radius of ¼ inch at inside back corners, be made a standard of the association.

Trains Parting.

A. M. WAITT, W. LAVERY, F. H. SOULE, D. HAWKSWORTH and B. E. THOMPSON, committee.

During the discussion at the 1896 convention, it was shown that the railways were menaced by a continuation of "break-in-two" evils which we had confidently expected would be overcome by the introduction of the M. C. B. type of coupler. Figures were given at that time indicating that it was possible that this evil was being increased rather than diminished by the supposed improvement. Such a state of things would be truly alarming, and it is with pleasure that your committee can report that the M. C. B. coupler itself can be charged with the responsibility for increasing the danger of train operation.

Much has been said and written in the last few years about foundation brake rigging, and the need of greater care in its design and application. There is perhaps an equal, if not greater, need for study in the improvement in design and application of draft rigging and of the M. C. B. couplers on our freight equipment. The data obtained from replies to our circular of inquiry, together with an extended observation at home and abroad on our railways, have convinced your committee that some radical steps must be taken to improve and maintain in proper shape the couplers, draft rigging and attachments to same on our cars.

A summary of the facts obtained from the 31 railway companies, representing 37,490 miles of track and 376,010 cars, shows in an average period of 105 days the alarmingly large total of 5,775 cases of trains parting, 103 of which were accompanied by serious damage, and in some cases loss of life. This shows an average of 55 cases of trains parting per day, and this on only a very small percentage of the railway mileage of the United States. Of the above cases, fortunately most of them occurred at speeds of under 20 miles per hour, and many of them occurred just as the trains were pulling out after having slacked up. On one road where an exceedingly rigid investigation of every case of train parting has for some time been made, it was found that only $\frac{75}{100}$ of one per cent. of the cases occurred in connection with the application of air-brakes, and this experience seems to be substantiated by nearly all the reports.

The following table, tabulated from the replies to our circular of inquiry, will give a good idea of the comparative frequency of trains parting from different causes:

Total number of cases in 105 days		5,775
Average number of cases per day for 31 roads		55
Number of cases due to—		
Broken links and pins	1,517	26.27 per cent.
Link and pin drawbars in addition to above	1,081	18.72 "
Total due to use of link and pin drawbars	2,598	44.99 "
Broken coupler spindles	708	12.26 "
Broken coupler pockets	86	1.49 "
Defective draft rigging	228	3.94 "
Failure or defects in M. C. B. couplers or their attachments	2,155	37.32 "
Total	5,775	

In connection with the M. C. B. couplers and attachments which caused cases of trains parting, the details are as follows:

Number of cases due to—		
Worn knuckles	195	9.05 per cent.
Broken or defective locks	886	41.11 "
Excessive amount of slack in draft rigging	672	31.13 "
Improper adjustment of uncoupling attachments	234	10.86 "
Other miscellaneous causes	168	7.79 "
Total	2,155	

The foregoing figures give much food for reflection and action.

First.—It is seen that we are fully justified in considering links and pins a very weak and unsatisfactory feature in connection with coupling arrangements, and we should give all haste possible to consigning our remaining link and pin drawbars to "innocuous desuetude" and rid ourselves of one source of much expense, which it seems impossible to avoid as long as we are compelled to use the link and pin drawbar to any considerable extent.

Second.—We see that 708 coupler spindles broke, causing trains to part, as compared with only 86 similar cases from broken pockets. From this we are surely justified in unhesitatingly condemning the further use of spindles in all new couplers applied to cars in the future. There is very little excuse for perpetuating the spindle coupler, and as it is shown by the above figures to be an especially weak device, it is the recommendation of your committee that the Master Car Builders' Association put themselves clearly on record, in connection with their recommended practice, against the continuance of the use of spindle rear end attachments for couplers, and in favor of the general use of pocket rear end attachments, which rarely ever give out,

Third.—We notice, in connection with M. C. B. couplers that have caused trains to part, that 906 cases, or 42.04 per cent. have occurred from excessive slack in the draft rigging or improper adjustment of the uncoupling attachments. The result of both of these wrong conditions was clearly shown to one of your committee, a few days ago, in riding on a passenger train watching a freight train going in the same direction on a parallel track of a neighboring road. In this train were a large number of cars equipped with M. C. B. couplers; on at least 50 per cent. of these cars the draft springs were compressed to such an extent and the uncoupling attachments were so short that the connection between the uncoupling lever and the lock was drawn taut and apparently, in some cases, the lock was partially raised. With such a condition existing it is quite easy to see how the application of the brakes on cars in the rear or a sudden pulling out of the engine might compress the draft springs enough to fully open the lock and allow the train to separate. The condition of the cars on the train above referred to is a condition that the reports tabulated above would indicate as existing on nearly 50 per cent. of the cars where "break-in-twos" occur. In overcoming these two prolific sources of danger we have one of the most fruitful fields for work. Excessive slack in draft gear must be overcome by the exercising of greater care in maintaining draft rigging on cars in first-class condition, promptly replacing broken springs, bent followers, springs that have a considerable permanent set and preventing the use of short springs. It should be considered a defect rendering a car unsafe to run if it has 1 inch or more play in the draft rigging, so that by the hand the drawbar can be pushed back or pulled out 1 inch or more. It should also be considered that a car is in improper condition to run when the uncoupling attachments are so arranged that in their released position there is less than two inches slack in the chain connection between the lock and the arm of the uncoupling lever. It is true that a very large percentage of cars running have a less amount of slack in the uncoupling chain. This, in connection with the large number of trains parting, gives a most urgent reason for having a safe limit in connection with the slack in our uncoupling attachments, and your committee would impress upon the representatives of every road in the association the importance of requiring a proper adjustment of the uncoupling attachments and draft rigging on their cars in accordance with the preceding suggestions.

It is noticed that on many cars the end of the lifting arm of the uncoupling lever does not extend out as far as the center of the lock or lock pin; in good practice this should extend a little beyond the center, and attention to this point would materially improve the foundation uncoupling rigging on our freight equipment. In this connection your committee would urge the necessity of inventive genius in designing a simple uncoupling device so constructed that it will not lift the lock and uncouple the car until the coupler has been pulled out three or four inches from its normal position. Such a device would be very beneficial in overcoming a large number of cases of uncoupling due to improper adjustment of uncoupling attachments and excessive slack in draft gear.

Fourth.—The second largest source of trains parting in connection with M. C. B. couplers is due to broken or defective locks; this cause accounts for 886 cases, or 41.11 per cent. It is unquestionably true that the locks now in use in most of the M. C. B. couplers are not all that they should be. Many of them are so constructed that they will creep up by the peculiar pinching action produced by the motion of the car; many of them, dependent upon gravity, are lifted from their proper position by sudden blows which may be caused by the trains slacking up. These and other defects which have developed in the large majority of locking devices, supplemented by the expressions from the representatives of nearly every one of the roads heard from by your committee, warrant the committee in stating that it believes it necessary that coupler locks should be provided in some simple and effective way with a positive lock, which will prevent their being lifted from their locked position by any of the shocks, jars or motions produced in running cars; in other words, that there should be a lock to a lock.

Fifth.—The preceding table shows that 195 cases, or 9.05 per cent. of all cases, of uncoupling of M. C. B. couplers were due to worn knuckles. In view of the rapid increase in the number of M. C. B. couplers in use, and the fact that a large part of them have been in service long enough for the knuckles, and possibly the couplers themselves, to become considerably worn, and as it has been clearly shown that knuckles and couplers worn beyond a certain limit will permit of the knuckles passing the locks or the cars becoming separated without the knuckles opening, therefore your committee would recommend that during the coming year an investigation be made by a committee appointed for that purpose as to the limit of safe wear that can be allowed in knuckles and couplers, with a view of recommending to the association some simple and practical method for inspectors and others to use in determining when M. C. B. couplers and knuckles have become worn or distorted beyond the safe service limit.

In conclusion the committee would call attention to 168 cases, or 7.79 per cent., of uncoupling between M. C. B. couplers due to miscellaneous causes. Most of them can be assigned to broken couplers or knuckles. By the rules of interchange and the decisions of the arbitration committee, it has been declared that M. C. B. knuckles and couplers can be broken without any unusual rough handling. As the breakage of an M. C. B. coupler represents a loss of from $5 to $8, it behooves railway companies to protect themselves as far as possible against unnecessary damage of this kind, not only from the standpoint of doing so to prevent cases of trains parting, but from the standpoint of the cost of renewing such couplers when they are broken.

And in this connection your committee would recommend for the consideration of the roads representing the association, the application to their cars of either rigid or, preferably, spring buffer blocks. The use of such buffer blocks under severe tests in collisions has conclusively proven that both the couplers and the draft rigging are protected and saved to a very large extent where the blows are taken by double buffer blocks, which conduct the shocks through the car and train in a line with the floor timbers and sills.

Steel Underframing for Freight Cars.

Joint report of the following five members of the M. C. B. Association: J. N. BARR, C. M. MENDENHALL, R. P. C. SANDERSON, S. A. CHARPIOT and G. R. JOUGHINS.

Replies were received from most of the railroads addressed, and counted by the official votes in the Master Car Builders' Association. The recommendations represented over 760,000 freight cars. The above figure represents a large majority of the total freight cars in use in the United States that are owned by railroad companies. It may be prudent to mention that the reason for not asking for the opinion of private line companies was, that as their cars are mostly for special use, the dimensions they might recommend would not be the most desirable for general railroad interchange service. After the information referred to had all been gathered in, tabulated and distributed to the members of the committee for their consideration, the second meeting of the committee was held, at which the above information, and all that had been written and published in the discussions on the large-car problem at the railroad clubs and in the papers, as well as the action taken up to that time by the traffic associations, were given careful and thoughtful consideration, as the result of which the committee came to the conclusion that the designs to be presented by them to the convention this summer should be governed by the following conditions:

First, the inside length should be 34 feet for a standard box car of 60,000 pounds capacity. The vote for this particular length and 34 feet 4 inches being 509,000 cars, while the only other dimension receiving a vote of any considerable strength was 36 feet, which received 90,000 votes.

Second, the inside width should be 8 feet 4 inches for a standard 60,000-pound capacity box car.

Third, the height from the top of the floor to the top of plate should be 7 feet 6 inches for a standard 60,000-pound capacity box car.

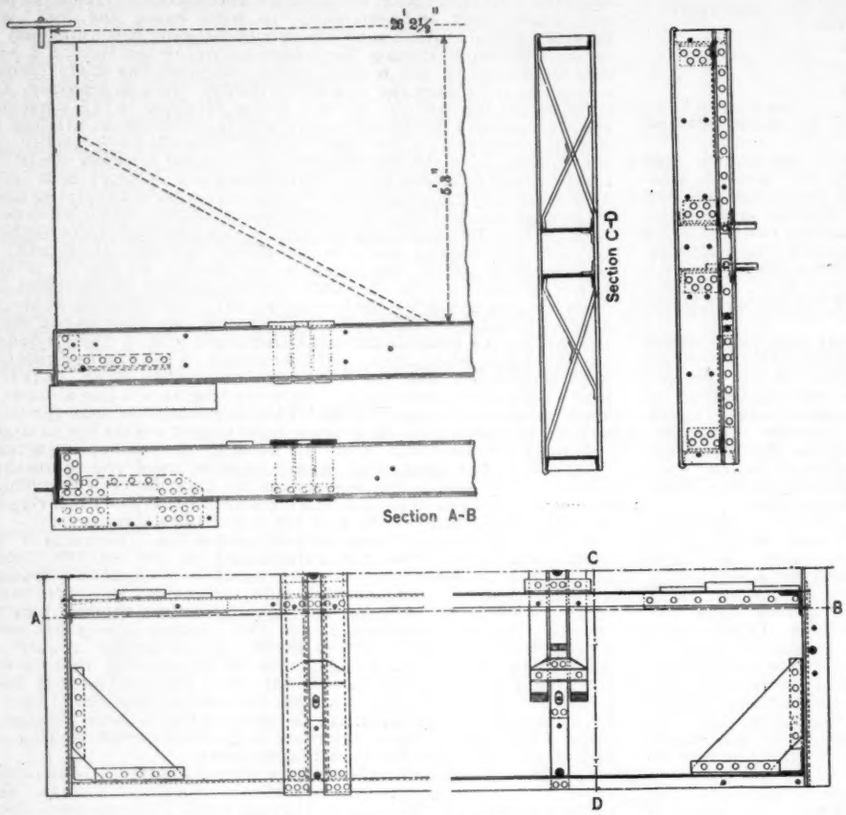
Fourth, the width of the side door should be 5 feet 4 inches clear for all box cars.

Fifth, the end doors, if any are used, should be 24 inches wide by 36 inches high.

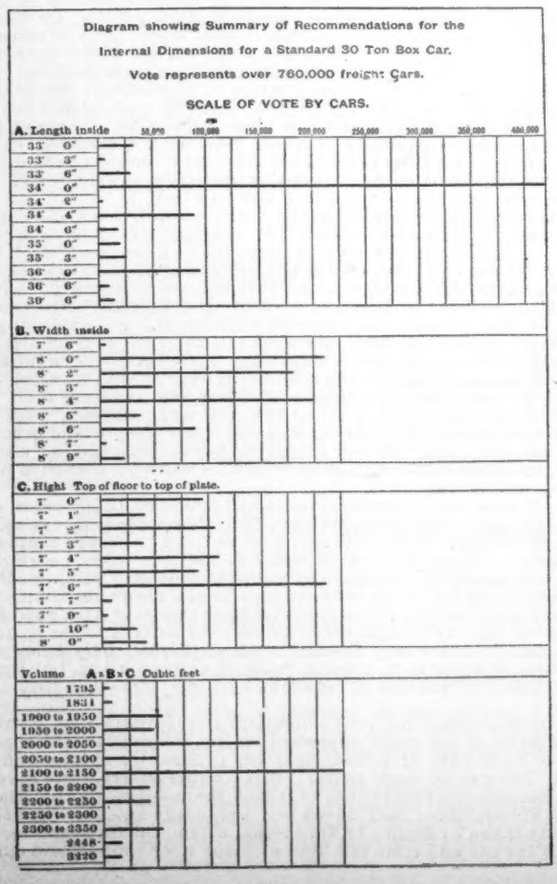
Sixth, the height from the top of the rail to the top of the floor should be 4 feet 2 inches.

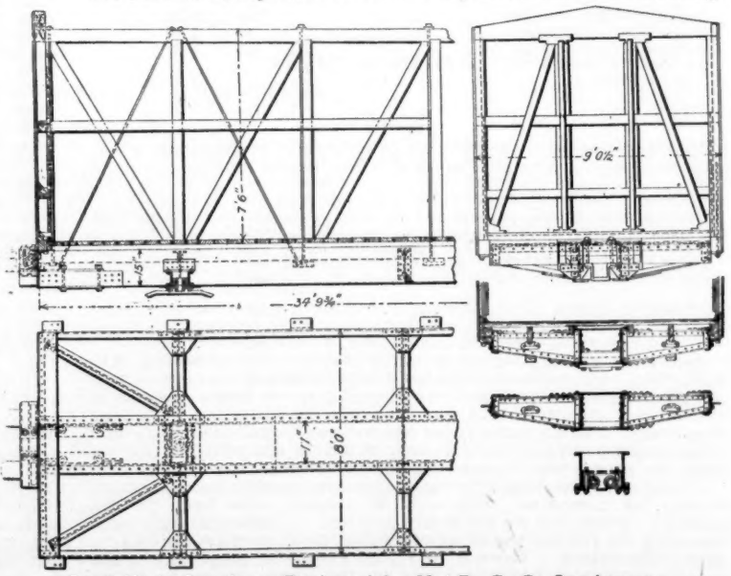
Seventh, the design should show the end sill flush and not projecting beyond the siding.

It is particularly desirable, whatever design of steel underframe be adopted as standard or as recommended practice of your association, even if the detail of the fastenings and less important parts be left to the individual choice of the builder, that the length, section and weight of the main sills, end sills, draw gear and bolster be shown on the association's drawings, so that the rolling mills and car builders who wish to take up the question of manufacturing the steel frames for 60,000-pound capacity cars can take advantage of market fluctuations to buy stock when prices are low, with the assurance that the size and length of sills will surely be used by any railroad companies ordering freight cars with steel frames and, further, that the stock of sills carried by railroads for their own use can also be depended on to suit any steel-framed interchange freight car that may be damaged on their line. Therefore, in presenting these drawings for the criticism, choice, and, we hope, approval of your association, we earnestly urge that the dimensions for a standard interchage freight car mentioned above, to which these drawing have been made to conform, should be submitted to the association by letter ballot, for adoption as standard, and that



Steel Underframe.—Norfolk & Western Railroad.



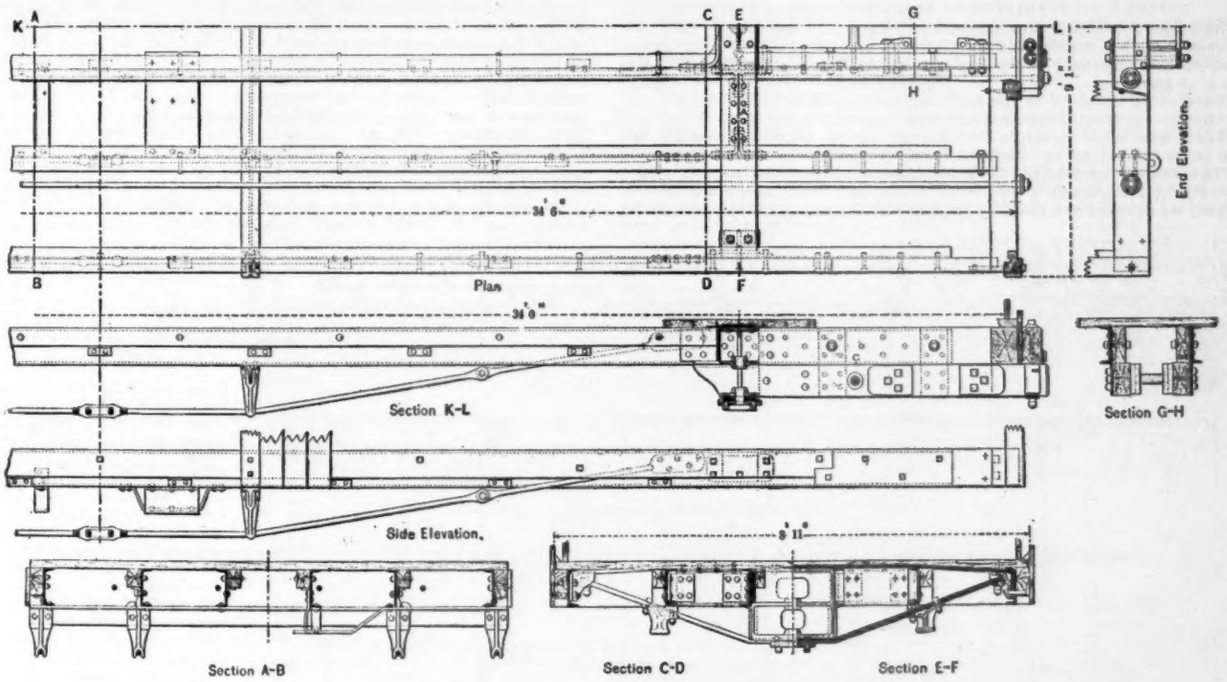


Steel Underframing.—Designed by Mr. R. P. C. Sanderson.

the association will make a choice of one of the designs presented and adopt it or its leading features and dimensions as recommended practice.

Your committee also specially urges that the dimensions recommended for standard interchange box cars, as far as length of sills, width and height from the rail are concerned, should be also adopted for other flat-bottom freight cars of 60,000 pounds capacity, such as stock, gondolas and flat cars, so that the same standard steel sills, bolsters, end sills and draft gears will suit for all these classes of cars of the same capacity.

With reference to the question of increased capacity of freight cars for general interchange service, your committee requested the railroads to give it their recommendations for the size of a standard box car of greater capacity than 30 tons. The replies received indicate that the great majority of the motive power officers of the railroads were not prepared to consider a car of greater capacity than 30 tons for general interchange service. A few sent recommendations for such a car, and of these only one or two recommended dimensions any larger than those they had recommended for 30-ton cars. It is probable that with the general introduction of steel framing for freight cars a greater capacity than 30 tons will be found to be economical, especially where loads can be obtained in both directions, and that the objection to, or unwillingness to consider, cars of greater dimensions than those now used for 30 tons capacity has been brought about by the unceasing trouble caused to the operating departments by the presence of a small number of especially large cars, which are too often used by traffic officers as bids for freight and cause trouble in other ways which have been well ventilated in the recent discussions on the large-car problem.



Steel Underframe. Designed by Mr. J. N. Barr.

BILL OF MATERIAL FOR STEEL UNDERFRAMING FOR DESIGN SUBMITTED BY R. P. C. SANDERSON.

Mark.	No.	Name of part.	Length.	Specifications.	Wgt.
A	2	Center sills	34 ft. 9¾ in.	15-in. channel C. 1.	2,296.5
B	2	Side sills	34 ft. 9¾ in.	9-in. channel C. 4.	922.4
C	4	Center plate bracket channel	17 in.	6-in. channel C. 7.	73.6
D	4	Diagonal braces	5 ft. 2 in.	4-in. x 2½-in. tee T. 63	150.6
E	4	Center plate bracket angles	14 in.	5-in. x 3 in. angle A. 203	46.4
F	16	Side bracket angles	9 in.	5-in. x 3-in. angle A. 203	120.0
G	20	Center sill corner angles	12½ in.	2½ in. x 2½ in. A. 48	124.8
H	20	Side sill corner angles	7 in.	2½ in. x 2½ in. A. 48	70.0
I	4	End sill angles	2 ft. 9¾ in.	2½ in. x 2½ in. A. 48	67.4
J	4	End sill angles	17 in.	2½ in. x 2½ in. A. 48	33.8
K	4	Dead block angles	10 in.	2½ in. x 2½ in. A. 48	19 9
L	16	Cross-girder top angles	2 ft. 9¾ in.	2½ in. x 2½ in. A. 48	269.7
M	16	Cross-girder bottom angles	3 ft. 1 in.	2½ in. x 2½ in. A. 48	295.7
N	2	Bottom cover plate stiffening angles	17 in.	2½ in. x 2½ in. A. 48	16.9
O	1	Top cover plate, 33 ft. 5¼ in x 24 in. x ¼ in			675.3
P	1	Bottom cover plate, 17 ft. 6 in. x 24 in. x ¼ in			353.5
Q	2	End cap plates, 8 ft. x 8 in. x ¼ in			107.7
R	2	End plates, 8 ft. x 10½ in. x ⅜ in			211.4
S	2	End sill reinforcing plate, 3 ft. 1 in. long, ⅜ in. thick			105.7
T	4	End plate packing strips, 6½ x 3 in. x ⅜ in			8.2
U	2	Center plate bracket plates, 2 ft. x 18 in. x ¼ in			60.6
V	16	Center sill gusset plates, ¼ in. thick			202.0
W	8	Side sill gusset plates, ¼ in. thick			67.0
X	8	Cross-girder web plates, ¼ in. thick			203.6
Y	4	Draft chafing plates, 3.1 in. x 6½ in. x ⅜ in			100.3
					6,601.0
		Add for rivet heads			358 0
		Weight of steel frame			6,959 0

Note.—Letters under the column for specification refer to the Carnegie standard sections.

These difficulties, however, can be entirely overcome, it is believed, by the adoption of a standard cubic capacity per ton of 2,000 pounds for interchange box cars, assisted by the revision of the minimum freight rates by the traffic officers, which can be based on this standard unit of capacity per ton. It is, therefore, further recommended that the figure of 70 cubic feet per ton of 2,000 pounds for the capacity of freight box cars should also be submitted to the association by letter ballot for standard, this figure conforming with the dimensions for the box car mentioned in the early part of this report and to conform to which these drawings have been prepared.

A diagram is also submitted showing roughly the result by votes of the recommendations for the length, width and height for a standard interchange box car, which is presented for the earnest consideration of the members and may aid them in agreeing on standards for these important dimensions.

DESCRIPTION OF STEEL UNDERFRAMING FOR BOX CARS. SUBMITTED BY J. N. BARR.

In making the design for underframing of box cars, it has been the intention of the designer to meet certain requirements which do not come into consideration at all in the design of stationary metallic structures, but which appear to be of extreme importance in car construction. In the usual conditions of service, cars are constantly subjected to severe and often destructive shocks longitudinally at the middle point of the end, or at the location of the draft arrangements. In addition to the local damage resulting from these shocks, a tendency to distortion of the framing is caused, whereby the middle longitudinal sills, or center sills, move in one direction, and the intermediate and outside sills move in the opposite direction. This differential motion must be resisted, and if resisted by a very rigid and inflexible construction will result in injury and gradual destruction to the framing.

Cars are also subjected to frequent damage at the ends, and it is important to provide for ready and cheap repairs at this location, so that removal of parts may not involve the general framing of the car.

In the construction presented it is sought to provide for these requirements:

First.—The general frame is flexible longitudinally.

Second.—The end of the framing is so constructed that in ordinary cases of damage repairs can be made without affecting the general framing.

Third.—The means of attachment of draft rigging to car is readily removed without disturbing the general framing.

Longitudinal flexibility is obtained by avoiding all diagonal bracing and gussets by making the fastenings between sills as shown at *A*, so that a distortion will bend the fastening *A* and not shear the rivets, and by providing for longitudinal binding rods, *B*, running full length of the car.

The general framing is protected from damage by being discontinued 9 inches from inside of end sill. The end sill is carried by short wooden sills fastened to the through iron sills.

The draft timbers are fastened to iron plates which extend from the end sill to the transom. This plate can be removed without disturbing the general framing.

Vertical strength at the center of the car is secured by truss rods as shown.

It is not necessary to enter into a general description of the framing, which is already shown by the drawing.

DESCRIPTION OF STEEL UNDERFRAMING FOR CARS.

SUBMITTED BY G. R. JOUGHINS.

The ideas governing the designs submitted by me are—

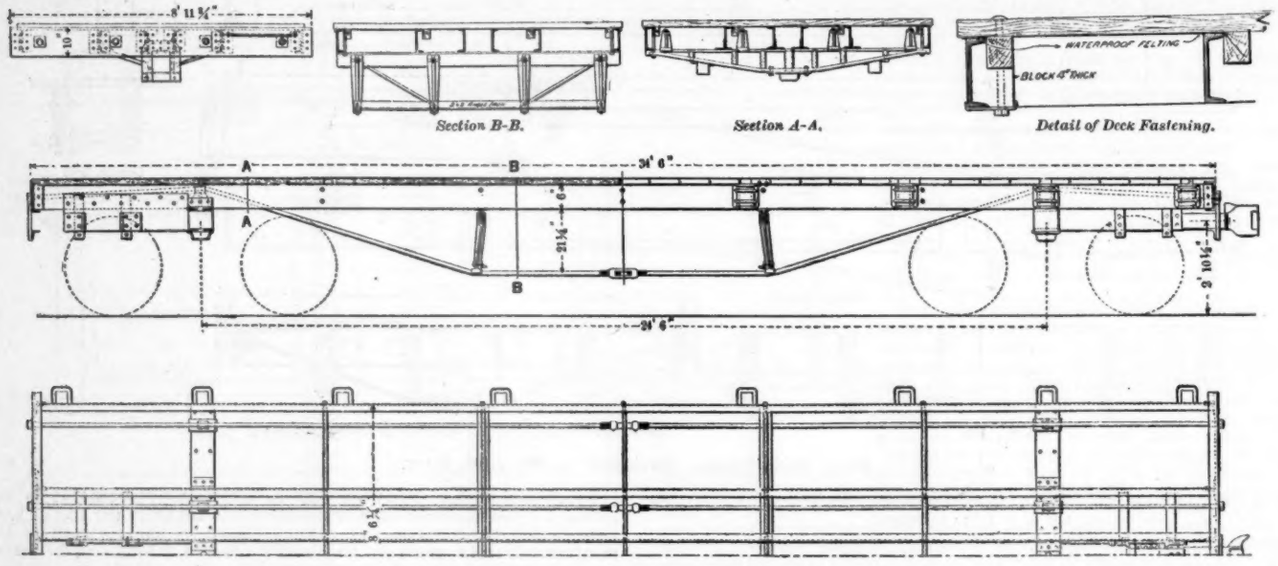
First.—Ample vertical strength.

Second.—Simplicity, avoiding blacksmithing and boilermaking as much as possible.

Third.—No holes in flanges of longitudinal sills.

Fourth.—Accessibility for painting, repairs, etc.

Flat Cars and Gondolas.—Several years' experience with flat cars built according to these designs, or more exactly according to the designs of the Norfolk & Southern car illustrated in last year's proceedings, shows only one weakness; that is the tendency of the stakes, when cars are heavily loaded with logs, to twist and distort



Steel Underframe. Designed by Mr. G. R. Joughins.

the side sills. This tendency can be overcome in many ways which will easily be suggested, but it is found that the web of the side sills ought to be $\frac{5}{16}$ of an inch thick to prevent them buckling, and that they must be braced to prevent them from twisting. On gondola cars this weakness would not exist. The platform, made up in four length, easily detachable from the frame, is found to be a great convenience when painting, etc.

Box Cars.—It must be acknowledged that, because the sills are protected from the weather, there is not the same necessity for steel sills on box cars as there is on open cars; moreover, the tops of the sills cannot be so readily exposed for painting. On the other hand, the steel sills would also enjoy protection from the weather, and therefore would not rust so quickly; it is furthermore expected that the great value of steel frames in strength, durability and economy will be so demonstrated by experience with open cars that their use will be universal. The underframe should be sufficiently strong to support the whole weight without assistance from the superstructure; indeed, it is hoped that the design of frame which would be used for flat and box cars will be identical, the only exception being the method of attaching the necessary timber work. The proposed method of attaching the superstructure to the sills is merely a suggestion, pointing out a possible means of connection; the ends particularly require close study.

General.—The designs are intended to convey the general principles advocated, combined with the results of actual experience with steel cars. Longitudinal sills should all be of the same depth to provide uniform support. The weights per foot of sills under cars in use are as follows: Center sills, 15 pounds per foot; side and intermediate sills, 11 pounds per foot; these side sills, although strong enough for vertical load, are too weak to properly hold the stake pockets under severe strains, and therefore the web should be $\frac{5}{16}$ of an inch thick. To conform to the new schedule of sections adopted by the rolling mills these weights should be somewhat increased.

To protect against rust, experience shows that, with untreated iron, periodical painting is absolutely necessary, but that very little rust develops anywhere except upon the tops of the sills on which the timber platform rests. A strip of waterproof felt laid on top of the sills would assist greatly in avoiding rust, and if the felt was cemented down with some compound (possibly P. & B. compound), it would probably avoid all rust and the necessity for frequent painting. It might be practicable to have the sills galvanized or laquered to prevent rusting. Draft gear between sills, as shown in the Norfolk & Southern car, is considered to be the best practice, if a satisfactory yoke coupler can be attached. The bolsters shown are not quite perfect—they bend upward immediately above the center plate. The bracing of bolsters to center sills seems to be useful. Poling pockets might be attached on the sides at the bolsters instead of at the ends.

Loading Logs, Poles, Bark, Etc.

P. LEEDS, L. P. BUSH, W. H. LEWIS, W. H. DAY, F. H. STARK, B. HASKELL, CHAS. COLLER, P. H. PECK and J. R. PETRIE, committee.

Your committee on the "Loading of Logs, Poles, Bark and Long Structural Material on Cars," sent out a circular inviting criticisms of the rules adopted in 1896, and received 24 replies, 20 of which are to the effect that the rules as adopted are perfectly satisfactory, while the other four find no fault with those rules, but suggest the addition of rules to cover the loading of pipe, tan bark, cordwood, ties, fence posts and dressed lumber. There have also been blueprints received showing the suggested methods for loading logs and pipe as per cuts. The methods proposed for the loading of tan bark, cordwood, ties, etc., conflict to the extent that about one-half advise loading crosswise of the car, and the others lengthwise; but they all agree that this loading, as well as dressed lumber, should be fully staked, and racked at the ends. A request for sketches showing this racking at the end brought replies to the effect that there was such a variety of construction that it would be impracticable to show it by sketch, but that where there were end stakes they should be utilized, and where there were no end stakes there should be cross-pieces from outside stakes nearest the end of car. This brings up the recommendation of the committee last year, that there should be uniformity in the staking of cars, and those stakes should be spaced so as to allow of the recommended practice being complied with. This would, in our opinion, be best accomplished by placing one pocket in the center on the side of the car, and spacing so as not to exceed 3½ feet from center to center of pockets, bringing the center of bolster approximately central between two stakes and placing the end pocket on the side as near the end sill as possible, so that one side of the stake would come in line with the inside of stake through the floor of car at the end, the pockets for which should be bolted to the inside of the inner sill. This staking would allow of sufficient stakes being used when lading was carried on two cars without spreading them to the extent of excessive binding when on a curve, or at least to a greater extent than the construction now prevalent. Where it was recommended that ties, cordwood, etc., be loaded lengthwise of the cars, it was very generally stated that the ends nearest the ends of the car should be raised and placed upon crossbearings securely fastened to the floor of the car. In view of the fact that most of this loading is local and not to any extent subject to interchange, the only recommendation the committee feels called upon to make is that all stone shall be cleated with strips not less than one and one-half inches thick nor less than four inches wide, securely fastened to the floor of the car with not less than one tenpenny fence nail to every nine inches, such nails to be staggered so as to be within one inch of the edge of the strip alternately. That lumber, dressed on one or both sides, when loaded on gondola or platform cars, must be racked at each end of the car in such a manner as to prevent the load from shifting. That all flat cars should have pockets applied in such a manner that the two end stakes and two side stakes at each end of the car can be utilized for this purpose. As regards the proposed methods of loading logs and pipe, while your committee fully approves of the pyramid methods, as shown, it prefers to submit the matter tentatively, and whichever (if either) method is approved by the association, prepare descriptive rules and present them for considera-

tion at a later day during this session. [A supplemental report was presented, which was based upon exceptions taken to the rules by the manufacturers of long structural material and inspectors handling the material.—EDITOR.]

Joint Report of Committees on Revision of Air Brake and Signal Instructions.

The report of this committee is in the form of the air brake and signal instructions with certain italicized additions. A new illustration was introduced to show the modern engineer's valve and the handle of the valve is shown in running instead of release position as formerly. Several of the other drawings have been modified in minor details. Some questions principally referring to the straight air brake have been ommitted entirely.

Box-Car Side and End Doors.

J. J. HENNESSEY, C. A. SCHROYER, GEO. F. WILSON, G. N. DOW and ROBT. GUNN, Committee.

Roads representing 180,000 box cars were in favor of the common batten door, while the balance of the roads were divided between the frame and flush doors. Roads representing 90,000 box cars were in favor of an overhung door with roller hangers, not patented. The balance of the roads, representing 112,000 box cars, were divided between the different patented hangers and the common slide hangers.

Your committee, after careful consideration and considerable labor, attempted to design an ideal box-car door, and at one time thought this accomplished, but after submitting the design to the Western Railway Association, it rendered a decision that the design was infringing on some patent rights. Judging from the replies received to the circular of inquiry a large minority, were in favor of an overhung door with roller hangers, not patented, while the majority of the roads which were in favor of the patented devices did not seem to agree on any particular device.

Your committee, therefore, submits the following designs for box car side and end doors, which it thinks will answer all practical purposes:

The side and end doors to be hung by two cast or malleable iron hangers to each door, each hanger secured to the door by three ⅝-inch carriage bolts and two ⅝-inch dowels, tapering to ½ inch. Each hanger to be supplied with a chilled cast-iron roller fitted into the hanger. The top rail to be ⅞ by 2½ inches wide, backed by a piece of oak running full length, being about 1½ inches horizontally and 1⅝ inches vertically, the rail to be fastened to this oak strip and through side or end plate by ½-inch countersunk bolts; about 20 inches apart.

The lower edge of door to have an iron rail ⅝ by 2½ inches, rabbetted flush into the lower cleat and projecting 1 inch below bottom edge of door, and fastened with button-head countersunk rivets ⅝-inch in diameter, passing through the ⅝-inch iron rail, bottom cleat and sheathing of door. These rivets to be about 18 inches apart; also two button-head rivets, ½-inch in diameter, passing through the ⅝-inch iron rail, ⅝-inch from bottom of rail, and so located that the button heads will come in contact with the door brackets when door closes, thereby holding door tight against car body when door is closed. The cuts accompanying this report fully illustrate the style of brackets to be used and location of same.

It is the opinion of your committee that it would be useless to recommend a standard size of door, as the door will have to correspond with the door openings of the various sizes of box-cars. The recommended door, however, is the common batten door, with three pine cleats 10 inches wide, and located at top and bottom edges and center of door on the inside, and filled in on the two side edges by filling strips 5½ inches wide, the door to lap 2 inches on closing side against an oak stop strip, running full length of door and fastened to the door post by ½-inch lag screws, the door to lap on door post on opposite side of door at least 4 inches. The door fastenings for seal to be the common hasp and eye bolt, in connection with the seal pin and tin seal, and located a suitable distance from bottom edge of door.

Taking everything into consideration your committee is of the opinion that the most practical end door fastening is that which fastens on the inside, requiring no seal, thereby saving considerable labor to the sealing clerks and the trainmen.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Thirtieth Annual Convention.

Ratios of Grate Area, Heating Area and Cylinder Volume.

G. R. HENDERSON, A. S. VOGT, R. WELLS, S. M. VAUCLAIN and C. J. MELLIN, committee.

In order to present an analytical discussion of the question, it was necessary to determine approximately the following points:

1. The force necessary to move a train of a given weight at various speeds and accelerations over various grades and curves.
2. The ratio of mean effective pressure in the cylinders to initial pressure, for various speeds, cut-offs and lengths of steam port.
3. The ratio of cut-off pressure to initial pressure for various speeds, cut-offs and length of steam port.
4. The evaporative value of different fuels at various rates of combustion per square foot of heating surface.
5. The evaporative value of different fuels at various rates of combustion per square foot of grate area.

It will be at once recognized, that if we are able to satisfactorily determine these various points, the proper heating surface and grate area needed by a locomotive for doing a definite amount of work can be readily calculated.

First, considering the subject of Train Resistance. After much research it was decided that the resistance due to speed was perhaps best represented by the formula published in *Engineering News*, of June 9, 1892, which is:

$$y_1 = \frac{S}{4} + 2,$$

where y_1 = resistance in pounds per net ton of load,
S = speed in miles per hour.

The force for starting is, however, about 20 pounds per ton, which falls to 5 pounds as soon as low rate of speed is reached.

The resistance due to grades is expressed by

$$y_2 = 0.38\,M,$$

where y_2 = resistance in pounds per net ton of load,
M = grade in feet per mile.

The resistance due to curves is generally taken at from 0.5 to 0.7 pounds per ton per degree of curvature. Selecting the latter value, and assuming that locomotives, on account of their long rigid wheel base, produce double the resistance of cars, we have

$$y_3 = 0.7\ C \text{ for cars,}$$
$$= 1.4\ C \text{ for locomotives,}$$

where y_3 = resistance in pounds per net ton of load,
C = curvature in degrees.

It may also be desirable to consider the resistance due to acceleration of the speed of the train, and it is found that this can be expressed by the formula

$$y_4 = 0.0132\ V^2$$

where y_4 = resistance in pounds per net ton of load,
V = speed attained in one mile, expressed in miles per hour, starting from rest.

Diagram 1 gives a graphical representation of all these formulæ for convenient use.

Diagram No. 2 gives the ratio of mean effective pressure to initial pressure for various cut-offs and speeds. The shaded zones or belts are intended to represent the limits of port length between which we are likely to work in locomotive construction. For instance, the upper portion of a zone represents what may be expected when using an Allen valve, or when the length of port in inches bears approximately the ratio 0.12 to the area of the cylinder in square inches, and the lower portion when the ratio is approximately 0.05 This diagram was constructed by taking some of the data in the report of the Committee on Slide Valves, found in last year's proceedings of this Association.

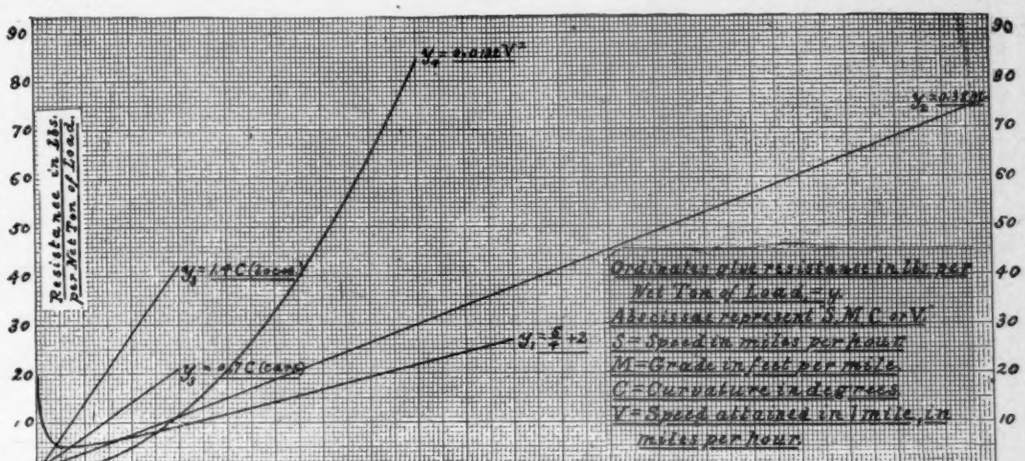

Resistance in lbs. per Net Ton of Load.
Ordinates give resistance in lbs. per Net Ton of Load = y
Abscissæ represent S, M, C or V
S = Speed in miles per hour
M = Grade in feet per mile
C = Curvature in degrees
V = Speed attained in 1 mile, in miles per hour

Diagram No. 1.—Train Resistance Curves.

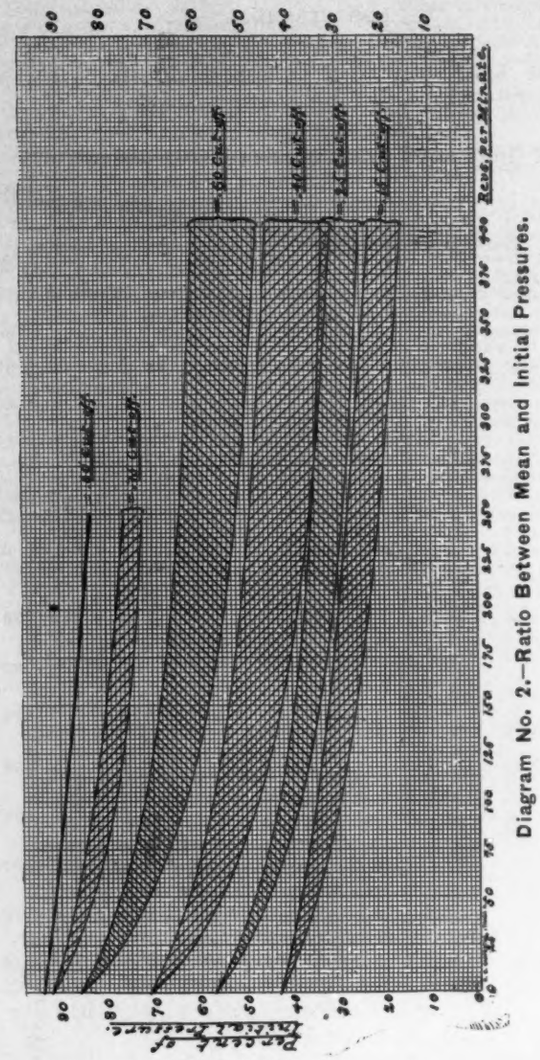


Diagram No. 2.—Ratio Between Mean and Initial Pressures.

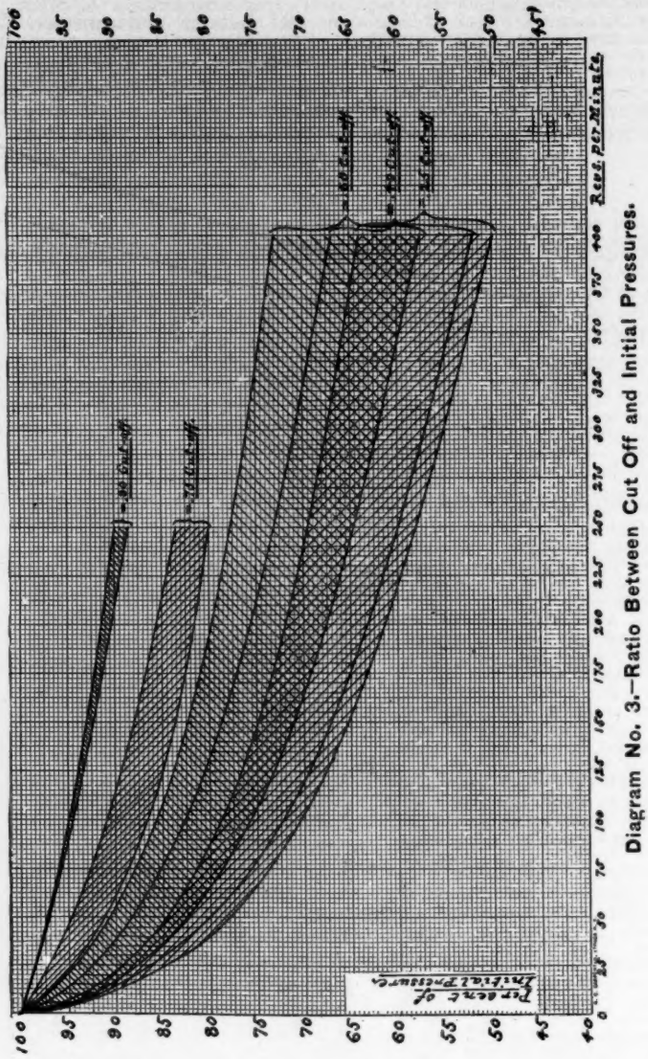


Diagram No. 3.—Ratio Between Cut Off and Initial Pressures.

Diagram No. 3 gives similar information in regard to the cut-off pressures, and the explanation above will answer for this also. Your committee wishes to state that diagrams 2 and 3 have been verified as far as possible, with gratifying results. A clearance of 8 per cent. was allowed in computing these curves, and the pressures are all "above the atmosphere." It is with some hesitation that diagrams 4 and 5 are presented, as there are so many varying conditions in coal trials that any diagrams of this kind can be but the merest approximations. However, as they may be of some interest, diagram No. 4 is given to represent the evaporative value of fuel at different rates of combustion per square foot of heating surface per hour, and No. 5 the same at different rates of combustion per square foot of grate area per hour.

The individual curves designate some one kind of coal, or test of same. The following table will interpret the several curves:

INDEX TO EVAPORATIVE VALUE OF FUELS, DIAGRAMS 4 AND 5.

No.	Location of Mine.	Kind of Fuel.	Ratio of Heating Surface to Grate Area.
1	Pennsylvania.....	Anthracite, large.	45
2	"	" "	20
3	"	" fine.....	20
4	"	" "	20
5	"	Semi-bituminous.....	70
6	"	"	84
7	Virginia.....	"	66
8	"	"	57
9	"	"	49
10	Illinois..... ..	Bituminous.....	50
11	"	"	55
12	"	"	71

No. 13 had a ratio of heating surface to grate area of 100, but the kind of fuel is not positively known—it probably resembled a lignite.

No. 14 represents Professor Goss' experiments with diminishing grate areas.

Nos. 15, 16 and 17 represent the experiments of the Paris, Lyons & Mediterranean Railway, made a few years ago with various lengths of tubes, the dimensions being 10 feet, 15 feet and 20 feet, respectively.

It would appear, from a study of these diagrams, that there is a loss in efficiency of fuel by increasing the rate of combustion per square foot of grate area per hour, which is chiefly accounted for by the unburnt coal which passes out of the stack, and which loss is represented by curve 14; and a loss by increasing the rate of combustion per square foot of heating surface per hour, which is due to the fact that the gases pass over the heating surfaces more quickly, and which is partly represented by curves 15, 16 and 17. Under the conditions which exist in ordinary locomotive service, therefore, we may expect a steeper curve, occasioned by the loss in efficiency from both causes, and it will be seen that most of the curves have this increased slope.

From these diagrams it is patent that results widely apart can be obtained with the same coal, and, therefore, your committee considers that the best way to attempt to represent the value of fuels will be by zones instead of single curves. The upper portion of the zone may be taken to give the values of good grades of fuel under favorable conditions, and the lower portion when circumstances are not so favorable. This zone may be subdivided for different kinds of coal, and the diagrams show what is considered a fair division in this respect. This, of course, applies only to the proportions usually found in locomotive boilers. It would appear from diagram No. 4, that a poor coal might be made to yield almost as much economy as a better coal, if the rate of combustion were properly reduced. This shows that, in general, the boiler of a locomotive should be as large as possible, being limited only by the weight which is allowable and the clearances of the railroad, and that in designing a locomotive every part should be made as light as possible, consistent with strength, and the boiler, or really the water in the boiler, should utilize every surplus pound of weight available.

FACTOR OF EVAPORATION.

As the factor of evaporation for the pressures and temperatures of feed-water usually occurring in locomotive practice varies between 1.15 and 1.25, we may consider 1.2 as an average value.

INTERNAL FRICTION.

Wellington places the internal friction of the locomotive (not including the journal and rolling friction) at from 5 to 8 per cent. of the indicated power; Forsyth (C., B. & Q.) at 10 per cent.; and *Engineering News* (Vol. 27, page 585) at 5 per cent. It may, therefore, be assumed at from 5 to 10 per cent. of the indicated power, or in

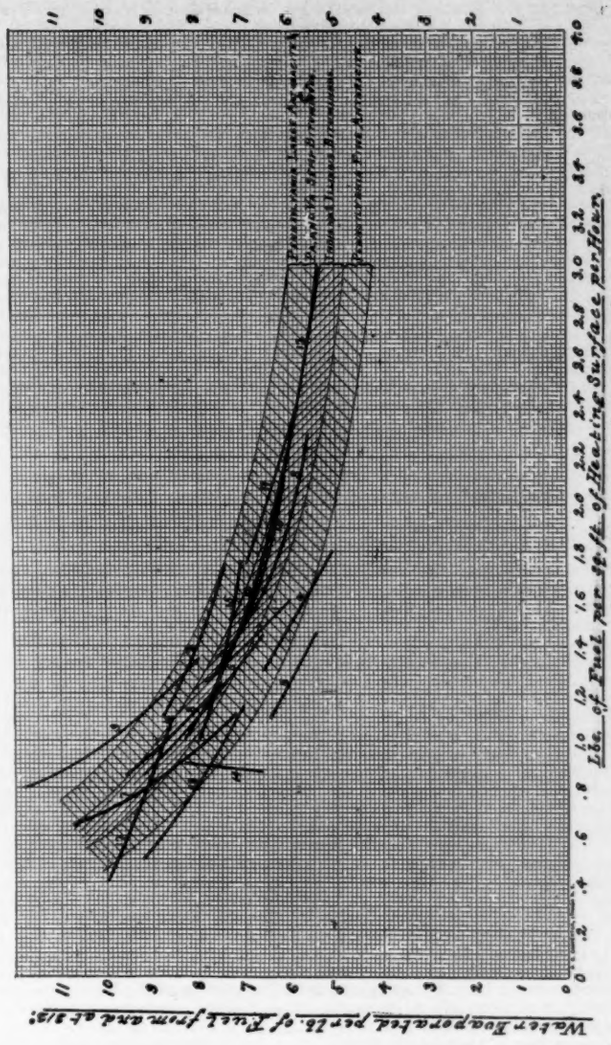


Diagram No. 4.—Evaporative Values of Fuels.

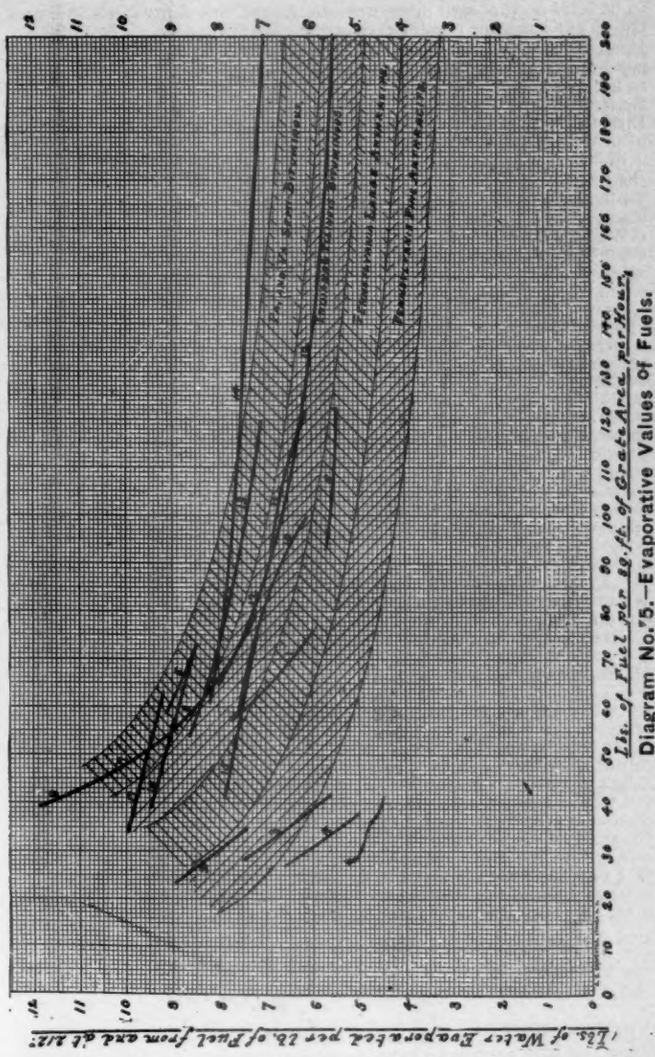


Diagram No. 5.—Evaporative Values of Fuels.

round numbers the theoretical tractive force (indicated tractive force) may be taken as 10 per cent. greater than the actual tractive force, which actual tractive force is utilized not only in drawing the train, but in overcoming the journal and rolling friction of the engine and tender as well, these to be taken at the same rate as the train itself.

TRACTIVE FORCE.

As is well known, the theoretical tractive force is represented by the equation:

$$\text{Theoretical tractive force} = \frac{pd^2 s}{D} \text{ in pounds}$$

where p = mean effective pressure in pounds per square inch,
d = diameter of cylinder in inches,
s = stroke in inches,
D = diameter of driving wheel in inches.

From what we have seen above, we can therefore write

$$\frac{pd^2 s}{D} = 1.1 (y_1 + y + y_3 + y_4) T$$

where T = weight of train in net tons, including the engine and tender, and y to be taken from Diagram No. 1.

The mean effective pressure depends principally upon two factors, the boiler pressure and the cut-off, modified by the initial pressure and the speed, which reduces the cut-off pressure below the initial. While the mean effective pressure fixes the tractive force, yet the actual cut-off pressure bears an important effect upon the tendency to slip the wheels at different parts of the revolution.

If we consider the friction between the wheels and rail to be 22 per cent. of the adhesive weight, and a loss of 10 per cent. due to the internal friction of the engine, we can conclude that the theoretical rotative force at the circumference of the wheel must never exceed 25 per cent. of the weight on the drivers.

The point of maximum rotative force varies 15 degrees each side of the 45 degree point.

To prevent slipping we may therefore conclude that the average tractive force should not exceed 22 per cent. of the adhesive weight, as this would prevent the maximum rotative force exceeding the 25 per cent. found above, in all out the ⅛ and ¼ cut-off, and as the speeds are generally high at these points, the inertia of the wheels, etc., would probably prevent slipping at the maximum points.

In 1887, a committee of this association advised that the coefficient of friction between the wheel and rail might be taken at 25 per cent. for passenger and 23 per cent. for freight locomotives. This committee also recommended using the diameter of wheel when the tire was half worn, instead of the diameter when new, in figuring the tractive force. This would give us values of about 24 per cent. and 22 per cent. for passenger and freight, respectively, when the full diameter was used, so your committee accepted 22 per cent. as the proper co-efficient in both cases.

EVAPORATION.

Diagram No. 3 and Tables D and E enable the weight of the steam used per stroke to be determined, and Table B the weight of steam per hour. This, of course, is the "water accounted for by indicator" and should have about 25 per cent. added for condensation and other losses. It should also be multiplied by the factor of evaporation, 1.2, to obtain the amount of water from and at 212 degrees.

EXAMPLES.

Take a 10-wheel engine, 19 by 24-inch cylinder, 60-inch drivers, boiler pressure 150 pounds, 28 square feet grate area, and with 100,000 pounds on drivers. This engine is capable of pulling a passenger train of 300 tons gross weight up a 70-foot grade at a speed of 30 miles per hour, the fuel being Pocahontas coal. From Diagram No. 1 it is found that the value of y_1 at 30 miles per hour is 9, and the value of y_3 on a 70-foot grade is 27, making a total resistance of 36 pounds per ton. Therefore we have (allowing the 10 per cent. for internal friction above referred to) $36 \times 300 \times 1.1 = 11,880$ pounds, say 12,000 pounds total resistance. The mean effective pressure necessary to do this work would therefore be $\frac{12,000 \times D}{d^2 s} = p$ (see formula 2), or $\frac{12,000 \times 60}{361 \times 24} = 83$ pounds M. E. P, and as the initial pressure may be 140 pounds, we find from Table C that the M. E. P. is 60 per cent. of the initial pressure. From Table B it can be seen that a 60-inch wheel makes 168 revolutions per minute at 30 miles per hour, while from Diagram No. 2 it is found that with Allen valves (which this engine uses) a cut-off of about 50 per cent. is necessary. From Diagram No. 3, it appears that with 50 per cent. cut-off and 168 revolutions per minute, the cut-off pressure will be about 78 per cent. of the initial pressure. From Table C this is found to be about 110 pounds per square inch, and Table D gives the volume of a 19-inch cylinder 12 inches long as 1.97 cubic feet, or, say, 2 cubic feet of steam per stroke. Table E shows the weight of steam per cubic foot at 110 pounds pressure

to be 0.284 pound, and allowing the factor of evaporation, 1.2, and the 25 per cent. for condensation, etc., we have:

$$\left.\begin{matrix}\text{Pounds of water}\\ \text{per hour from and}\\ \text{at 212 degrees}\end{matrix}\right\} = 2 \times 4 \times 168 \times 60 \times 0.284 \times 1.2 \times 1.25 = 34{,}352.$$

Now, allowing 6½ pounds water per pound of coal (on account of the high rate of combustion), and also dividing by the 28 square feet of grate area, we have

$$\frac{34{,}352}{6.5 \times 28} = 189 \text{ pounds of coal per square foot grate area per hour,}$$

which, it will be evident, is about the maximum capacity of the engine.

We will now proceed to illustrate how the amount of heating surface and grate area can be determined from the foregoing data, when the cylinders, wheels, etc., of the locomotive have been decided upon, these, of course having been determined by means of formulæ 1, 2 and 3 and the data following them. To do a certain amount of work we can use a smaller cylinder and cut off later, or a larger cylinder and cut off earlier, the diagrams and formulæ giving the results in either case.

Let us consider first that at the average work (that is, the work performed during most of the run) steam should be used at the most economical rate. This seems to be pretty generally conceded to be at one-fourth cut-off for simple and one-half cut-off for compound locomotives. It is also considered that while the maximum speed of a locomotive in miles per hour will be closely represented by the diameter of its wheel in inches, that the average speed at which it does most of its work will be about half that speed, or at 168 revolutions per minute. (Our figures now refer to passenger locomotives only.)

Cut-off at one-fourth stroke and 168 revolutions give by Diagram No. 3 a cut-off pressure of about 70 per cent. of initial pressure, which, if we assume to be 160 pounds, will give us 110 pounds at cut-off, weighing 0.284 pound per cubic foot.

Letting Vt = the volume in cubic feet of both cylinders (that is, 2 × area × stroke), we now have: Water per hour from and at 212 degrees in pounds =

$$\frac{Vt}{4} \times 2 \times 168 \times 0.284 \times 1.2 \times 1.25 \times 60 = 2{,}147\ Vt \text{ or, say, } 2{,}150\ Vt.$$

If for freight engines, we assume ⅝ cut-off and 120 revolutions per minute, we have nearly the same result, namely, $2{,}150\,Vt$.

So far we have proceeded without any reference to the fuel used, but now we must make more assumptions, and decide that an economical rate of evaporation should be maintained under the above conditions. From Diagrams 4 and 5 it appears that large anthracite will evaporate 8 pounds of water per pound of coal, when the rate of combustion is 1½ pounds per square foot heating surface per hour and about 60 pounds per square foot grate area. This will give, for large Pennsylvania anthracite coal,

$$\text{Heating surface in square feet} = \frac{2{,}150}{8 \times 1.5}\ Vt = 180\,Vt.$$

$$\text{Grate area in square feet} = \frac{2{,}150}{8 \times 60}\ Vt = 4.5\,Vt.$$

In ascending heavy grades the fires will be forced to two or three times the rate specified above, in which case the cut-off may be 0.5 or 0.6, or even 0.75 of the stroke, thus greatly increasing the work of the engine, as we saw in the first two examples. Of course there is a limit to the rate of combustion, which seems to be about 200 pounds per square foot of grate area per hour for bituminous coal. Your committee could not ascertain the limit for anthracite coal, but it is evidently much lower.

The circles denote engines which were reported as indifferent steamers.

In all the foregoing calculations, we have based our figures on simple or single expansion engines only. In compound locomotives, the consumption of water will be about 10 per cent. and of fuel about 20 per cent. less than in simple engines.

In calculating the quantity of steam used, the volume Vt should, of course, include only the high-pressure cylinder or cylinders.

Your committee could find no reliable data on the relative value of firebox and tube-heating surface, some authorities assuming that the former was worth twice, and some ten times the latter. It will be seen to average in amount about 10 per cent. of the total heating surface.

The ratio of tube length to outside diameter is also important, and recently much longer lengths have been in vogue. The average seems to be about seventy diameters, although in the Paris, Lyons & Mediterranean Railway experiments, 90 diameters gave the most economical results, and this proportion is gradually coming into American practice.

CONCLUSIONS.

After a careful study of the foregoing data, your committee has reached the following conclusions:

The ratio of grate area in square feet to total cylinder volume in cubic feet should not be less than:

4 for large anthracite coal,
9 " small " "
3 " bituminous "

for simple passenger or freight locomotives.

The ratio of heating surface in square feet to total cylinder volume in cubic feet should not be less than:

180 for large anthracite coal,
200 " small " "
200 " bituminous "

for simple passenger or freight locomotives.

(The proportion for compound locomotives must be figured out by taking the volume of the high-pressure cylinder or cylinders and the desired cut-off in high-pressure cylinder, and calculating as in formula 4.)

The ratio of heating surface to grate area should not be less than:

40 for large anthracite coal,
20 " small " "
60 " bituminous "

for passenger and freight locomotives.

For coke and fuel oil the proportions for bituminous coal may be observed.

The ratio of firebox heating surface to total heating surface should be about 10 per cent.

The ratio of tube length to outside diameter should not be less than 70, and may be as much as 90.

The ratio of steam port length in inches to cylinder area in square inches for passenger locomotives should be preferably about 10 per cent. This can be accomplished either by using piston valves or Allen valves. In the latter case the Allen valve has been considered as doubling the length of the port. In freight locomotives, which naturally make less revolutions, the ratio may be from 5 per cent to 8 per cent.

Finally your committee wishes to state that their deductions and calculations must always be used with discretion, and in every case the locomotive should be designed for the work it has to do, not merely accepting these general formulæ (4 to 12) for all the varieties of service without modification. The first portion of the report indicates how to proceed with such calculations in detail.

Best Metal for Cylinders, Valves and Valve Seats.

J. N. BARR, G. F. WILSON, G. W. STEVENS, F. W. MORSE and H. LUNDY, committee.

The question of the strength of locomotive cylinders is an extremely complicated one. It would be possibly more correct to define this as a question of the liability of locomotive cylinders to break in service. The tendency of a cylinder to break is only partially dependent upon the strength of the material of which it is composed. The form, the pattern and the shrinkage of the material from which the casting is made are the points upon which the tendency to breakage most largely depends. Owing to the fact that strains from shrinkage cannot be entirely avoided, the question of the shrinkage of the metal from which the casting is made becomes of paramount importance. It will readily be admitted that if the metal in the cylinder shrinks one-sixteenth of an inch to the foot in cooling, the internal strains will be much less than if the metal used should shrink one-eighth of an inch to the foot. It is therefore of the utmost importance that the metal selected for cylinders should show the least possible amount of shrinkage. The various kinds of pig iron differ materially in this respect, and in the same brand of pig iron the amount of shrinkage varies materially with the grade of the iron, the rule being that the higher the grade or the harder the iron the greater will be the shrinkage of the casting made therefrom.

It is necessary to consider the question of hardness directly in connection with that of shrinkage. The metal composing the cylinder must be soft enough so that the boring and planing operations can be properly performed. The easiest and most accurate way of determining the hardness of a metal is to pour from the metal, when molten, a chill test—that is, to pour a small casting so that a portion of the casting is formed against an iron chill. Unless iron is extremely soft there will be found on breaking the casting a certain depth of white iron formed against the chill, and the depth of this white iron will vary directly as the hardness of the metal from which the casting is made. If a casting is made from a metal for which the chill test shows a depth of about one-half inch of white iron, the casting can be comfortably worked on the planer and boring machine. If, however, the chill test shows a depth of three-fourths of an inch white iron, it can be worked with considerable difficulty, although when wheels are made with a metal of this hardness, or even harder, they can be bored with reasonable facility. This, however, depends also upon the brand of metal which is used. With certain mixtures of iron, a chill test showing one-half inch will indicate a casting which is very difficult to work. But, without going into these fine details, a chill test of one-half inch white iron will give a casting, which in the shape of a cylinder can be satisfactorily put through the ordinary machining operations.

If the iron chills materially deeper than this, the difficulty of machining will be so great as to condemn the casting. Even if the casting could be machined the excessive shrinkage of such hard metal would cause serious trouble from cracking of the cylinders in service.

When we consider the question of friction, both in the case of the cylinder itself and the valve seat, there seems to be no reason to hesitate in saying that the harder the wearing surface the better the results, both as to wear and frictional resistance. This is undoubtedly true within the limits of a cylinder casting, and is possibly true within any limit. The problem, therefore, in the case of a cylinder composed of one piece narrows itself down to that of providing the hardest possible cylinder consistent with the necessary freedom from breakage, and with machining requirements.

It is believed by your committee that the chill test described above is an accurate indication of the hardness of the iron, and that ½-inch depth of white iron, or, as it is generally expressed, a "half-inch chill," represents the extreme of hardness permissible in a cylinder casting.

A shrinkage test could be made by casting a square bar 1½ inch in cross-section and 2 feet long, casting the ends of this bar against iron chills placed accurately 2 feet apart. The length of the bar, when cold, will represent the shrinkage tendency of the mixture used. This test should always be made in combination with the chill test, as the same iron will show less shrinkage when chilling ¼-inch than when chilling ½-inch.

In the matter of metal for valve seats, the question is—"Should the metal for valve seats be the same or different?"

A number of tests have been made of brass slide valves, and, so far as your committee have been able to ascertain, the results have been unsatisfactory as compared to cast-iron, both as to frictional resistance and wear. Your committee cannot do better on this point than to quote from Joshua Rose as follows: "Cast-iron in some situations is far more durable than hardened steel; thus when surrounded by steam it will wear better than will any other metal. Thus, for instance, experience has demonstrated that piston rings of cast-iron will wear as smoothly, better and equally as long as those of steel, and longer than those of either wrought-iron or brass, whether the cylinder in which it works be composed of brass, steel, wrought-iron or cast-iron; the latter being the most noteworthy, since two surfaces of the same metal do not as a rule, wear or work well together. So also, slide valves of brass are not found to wear so long or so smoothly as those of cast-iron, let the metal of which the seating is composed be whatever it may; while, on the other hand, the cast-iron slide valve will wear longer of itself and cause less wear to its seat, if the latter is of cast-iron, than if of steel, wrought-iron, or brass."

If greater hardness is desired in the wearing part of the cylinder and valve seats than is consistent with the strength of the body of the cylinder, the same can be secured by the use of bushings and false valve seats, and this course is recommended by a number of members.

In conclusion your committee recommends:

1. That as a rule cylinders should be as hard as is consistent with machining requirements.
2. That the matter of shrinkage should receive close attention in making cylinder mixtures.
3. That members having the facilities should make systematic tests of the hardness, shrinkage and strength of metal used in cylinder castings and supplement the same with chemical analyses.
4. That valves should be of cast iron.

Counterbalancing Locomotives.

E. M. HERR, S. P. BUSH, W. H. LEWIS and C. H. QUEREAU, committee.

In accordance with instructions your Committee on Counterbalancing designated 11 railroads to confirm or disprove our recommendations in the report submitted at the 1896 meeting. Of these 11 roads only four have reported, viz.: Pittsburg, Cincinnati, Chicago & St. Louis, Northern Pacific, Chicago, Burlington & Quincy, Louisville & Nashville.

In every case the report has been favorable, all concurring in the opinion that the engines tested rode at least equally well when balanced by the rule recommended as by the usual rule of balancing two-thirds of the reciprocating weights, regardless of the weight of the engine.

The engines tested were of different types, from 8-wheel, mogul and 10-wheel engines in fast mail and passenger service to heavy consolidation engines in fast freight service. In order, if possible, to be able to present more data than could be obtained from the roads designated, requests for information of the action of engines balanced in accordance with the rule recommended by the committee were sent to forty-five other roads; nineteen replies were received, of which only six have tried the committee's method. In none of th se were any bad results reported from the use of the rule recommended, two reporting that a larger proportion of the total weight of the engine than $\frac{1}{400}$ could be taken as the allowable weight of the reciprocating parts on each side which could be left unbalanced.

One member reports $\frac{1}{300}$ as giving good satisfaction in an 8-wheel engine in fast passenger service. Another recommends using the rule recommended by this committee for short engines and increasing the unbalanced weight in proportion to the length of the engine.

From the result of actual tests on a number of different roads with differnt kinds of locomotives, and the further fact that the rule recommended coincides almost exactly in many well-designed engines with the method of counterbalancing long in common use and has received the indorsement of every road which has tried it, your committee has to report that the results obtained show that the principle upon which the rule is based is correct, and indicate that if the proportion of unbalanced weight allowed is incorrect it is on the safe side or too small, and that in any except very high speed engines a larger proportion of unbalanced reciprocating weight might safely be allowed.

The recommendations of the committee might be criticised because the greater unbalanced reciprocating weight throws greater stresses on the frames and adjacent parts. The stresses from which the track is relieved by increasing the unbalanced weight of the reciprocating parts are, of course, thrown upon the frames and other parts of the engine itself. It is readily shown, however, that the stresses from the amount of unbalanced weight allowed by the rule recommended at the assumed maximum speed of as many miles per hour as the diameter of the drivers contains inches, will be only one-third or one-fourth, in ordinory types of locomotives, of the stresses thrown upon the frame by the pressure exerted by the steam against the piston. Furthermore, the greatest stresses from the reciprocating parts come at the part of the stroke when those from the steam are the least, that is, at the end of each stroke when steam is being exhausted. There is, therefore, no reason to apprehend any difficulty on this account.

The practicability of allowing a greater amount of reciprocating weight to remain unbalanced in long than in short engines, as suggested in the discussion of last year's report, has been considered. This is being tried by one road—the Great Northern—which reports, thus far, favorable results, although its experience is as yet limited to a small number of engines in service but a few months. A formula for determining the counterbalancing in terms of the length of the engine as well as the weight has been worked out by Mr. H. H. Vaughan, Mechanical Engineer of the Great Northern, and was explained in a paper read before the March meeting of the Northwest Railway Club. This formula disregards the longitudinal vibrations set up by the overbalance, and while doubtless correct for the "nosing" tendency, has been tried too short a time, in our judgment, to receive indorsement. The matter should be thoroughly investigated, however, as the results, if practicable, are decidedly advantageous.

The importance of adjusting the amount of counterbalance accurately is not generally appreciated. The effect upon the track and bridges is proportional to the overweight, and in high speed engines this weight should be as small as the rule adopted permits and not carelessly permitted to exceed this amount. If entire accuracy is not possible, the amount allowed by the rule should be reduced rather than exceeded.

This is especially true for the main wheel, as the rule recommended slightly overbalances this wheel on account of the weight of the back end of the main rod being considered as revolving weight, when in reality it is part revolving and part reciprocating. The error does not exceed 10 per cent. of the weight of the back end of the main rod, and is often much less.

Your committee, therefore, renews its recommendation contained in last year's report, which has been worded differently to correct an ambiguous sentence in the second part of the rule.

RULES FOR COUNTERBALANCING LOCOMOTIVE DRIVING WHEELS.

First. Divide the total weight of the engine by 400; subtract the quotient from the weight of the reciprocating parts on one side, including the front end of the main rod.

Second. Distribute the remainder equally among all driving wheels on one side, adding to it the weight of the revolving parts for each wheel on that side. The sum for each wheel, if placed at a distance from the driving wheel center equal to the length of the crank, or a proportionally less weight if at a greater distance, will be the counterbalance required.

Motors—Steam, Air and Electric.

J. H. MCCONNELL, JOHN PLAYER, W. C. ARP, WM. RENSHAW and V. B. LANG, committee.

Replies were received from 24 railroads and one locomotive builder, reporting 35 steam motors, 162 air motors and 229 electric motors. The Baldwin Locomotive Works reports in service 27 steam motors, 41 air motors and 220 electric motors. Two railroads report nine electric motors in service. Five roads report no air or electric motors in service. In a few instances motors are used with steam and air. Horse-power varies from 2½ to 10 in air motors, and from 10 to 50 in electric motors. Design of air motors both rotary and piston. In steam motors reference is made to stationary engines for driving shafting and isolated machines. Cost of air motors varies from $100 to $150.

Eighteen roads using air motors consider them the most economical and best adapted to the work in shop practice, and at the same time report no experience with electric motors. Air pressure reported shows: One road uses 40 pounds, one 60 pounds, four 70 pounds, one 75 pounds, four 80 pounds, two 90 pounds, four 100 pounds and one 115 pounds.

The committee finds a lack of data as to the relative cost, from a practical standpoint, per horse-power where these machines are used. It also finds the information absent where only one kind of machine is used. This is particularly true of air appliances, presumably on account of the different conditions that would necessarily have to be considered, it being practically in its infancy, as it is only in the last four or five years that it has been recognized as an important factor in all well-regulated shops.

The following are some of the items compressed air is universally used for in connection with suitable appliances, with an average of from 25 to 50 per cent. economy over the former practice:

Tapping out staybolt holes; screwing in staybolts; reaming and drilling holes; chipping and calking; removing tires; beading flues; air hoists, vertical and horizontal, and for all purposes including foundry and ice-house elevators; jacks for raising cars, trucks and locomotives; telescope jacks used in connection with drop pit for dropping drivers; press for forming tinware of every description; presses for general machine shop use and pressing in bushings, driving brasses, etc.; large boiler punches; shears, erected and used outside of shop for the purpose of shearing off test coupons; punching holes that would otherwise necessarily have to be drilled, as the ordinary power punch and shears is not of sufficient gap for the large sheets now going into general use; tank riveters; staybolt nippers and pullers; light stationary air hammers in blacksmith shop, made out of Westinghouse brake cylinders, to be used at tool dresser's fire or where general light work in done; shears at scrap pile for cutting up old bolts to standard lengths, and hammer for straightening; shear for light sheet iron work, made from Westinghouse cylinder at minimum cost; feed for upright nut-tapping machine, allowing operator to handle six taps; also drilling safety holes in staybolts before being screwed in firebox; machine for centering all bolts before turning; Westinghouse cylinders to operate vises without screw, by the operation of air apply couplings to and remove clamps from air hose; also the same appliances for operating a knife to cut off old hose from nipples; sandpapering machine; small Pelton wheel for operating small emery wheels; for sharpening tools in convenient places through the shop; blast for blacksmith forges; Westinghouse engine operating large transfer table; applied to mixing paint in large quantities by putting a pipe in the bottom of a barrel; used in all kinds of motors for boring cylinders and facing valves; grinding steam pipes; driving any

special machine when line shaft is not running; cleaning out flues; in connection with gasoline for removing tire; cleaning cushions and carpets in and out of cars; blowing out cylinders before applying packing; testing staybolts; also to move engines to other locations; for different purposes, such as painting, bending pipe, operating letter press, rolling flues, swedging flues, testing brakes, painting cars, sanding roofs, bridges and depots, and several other purposes.

Your committee is decidedly under the impression that both air and electricity are an advantage over steam for portable motors, and also there are conditions existing where the electric power is preferable for large permanent motors via line shaft, for driving large tools, and where a convenient operation of an overhead crane is desired. Leaving the latter out of the question, however, where a line shaft can be conveniently operated with a well-designed stationary plant, your committee is under the impression the latter is the more economical.

For small, portable tools the air motors are no doubt more convenient, if not as economical. As the committee is unable to gather any definite information based upon practical results that would assist us to establish that fact, but considering the danger of electricity which exists to some extent at least, and then considering the convenience of air in and around the shop and the fact that any ordinary mechanic can repair, look after and handle air motors, the relative difference would have to be considerable to make the former preferable; however, the power transmitting capabilities of each in combination with their other individual and peculiar lines of usefulness open for them a distinct and separate field in which neither can be substituted for the other; therefore, it is well to anticipate the possible requirements for other than the transmission of power before coming to a final conclusion.

It seems to be certain that power may be transmitted by compressed air for a considerable distance with less loss than by any other known means. This is not figuring from the moment compression ceases, as there is an inevitable cooling of the air at that time with its necessary loss, but this figure is to be taken after it has assumed its normal temperature, when its loss from any considerable distance is practically nothing.

For general railroad work, with the exception of special cases and conditions as enumerated, a well-designed air plant will be the most convenient and economical, all things considered.

A shop turning out 60 engines per year, with general repairs, has been equipped with an air plant consisting of one compressor, 15-inch steam, 14-inch air and 18-inch stroke cylinders; five ice-house elevators; one hoist for driving wheel lathe; six hoists for lathes and planers; two brotherhood engines; three motors: one pneumatic hammer; one plant for testing air-brakes; one sand elevator; one fire kindler; one flue cleaner.

The cost of the compressor, including foundations and pipe connections, was $1,260.50. Pipe lines, hose, valves, reservoirs, motors, hoists, elevators and other appliances cost $1,189.50. Total, $2,450.

On a test run of eight hours, it required 313 pounds coal per hour, or 2,508 pounds for the eight hours' run.

It required five minutes and 40 seconds to raise pressure from 0 to 120 pounds. Compressor made 838 revolutions and compressed 2,681.6 feetof free air to 193.9 feet at 120 pounds. It requires with this compressor 20.4 pounds coal to compress 1,000 feet free air to 120 pounds, showing 60 per cent. of its theoretical efficiency. As the compressor has been in service 18 months, an overhauling of the cylinder packing and air valves would probably produce a higher efficiency.

Piecework in Locomotive Shops.

P. Leeds, Wm. Swanston, R. P. C. Sanderson, J. G. Neuffer and J. B. Michael, committee.

From the replies to the circular and from the fact that the value of any employee is in direct proportion to the amount and quality of the output resulting from his efforts, it (the piecework system) is, in the opinion of your committee, the most just and equitable method of employing men, as by this means the man who is skilled and industrious reaps the benefit of all the energy and brains expended, and is not put upon a level with one of inferior capacity, or the time server, while both he and his employer receive just what was agreed upon, and if there is a spirit of justice in the setting of prices, there will be no hardship on either side, and these prices should be based upon the average, both as to men and conditions. Even on new work it would be remarkable if there was no variation in the output by the same man, and in repairs, especially where old parts have to be separated, there is a great variation, and in the opinion of the committee the setting of prices should have the same consideration that a competent foreman would give where there are no prices affixed. Such a foreman certainly knows just how long a man should be upon any piece of work, and, failing to obtain proper results, should call the workman to account, and it is in just the extent that a man's pocket is a more inexorable taskmaster under the piecework system than the average foreman, that we may expect better results than would obtain under a competent foreman who had the authority to base the man's pay upon the results of his labor. The averaging of pay has been one of the curses of the daily wage system; there has been no particular incentive for one man to excel another, and it has drifted into an average day's work for an average day's pay. Another thing under the wage system that about offsets the danger of a lack of thoroughness under the piece system is the tendency to expend unnecessary labor on a piece after it is good enough for the service it is intended for. This, in our opinion, accounts for a large percentage saved under the piece system, as it is to the interest of the employee to stop when he gets through. If a man is so thoroughly proficient that he can turn out a great deal more work than any other, and by so doing receives much more wages than his co-laborers, there is no justice in reducing him to the average, even if he is the only one on that particular job in the shop, as the company pays no more per piece than it would pay to another, and, in case of a machine hand, obtains a benefit in the greater output of the machine. If we could increase the output of machinery or shops the 25 per cent. claimed for this system and reduce our plants or increase our facilities that much, that alone would be quite an object, even if we did not get any benefit in the ultimate cost of the labor. This certainly would mean 25 per cent. less time for equipment in shops and a saving all around, and as, so far as the committee is informed, this question is "with but few exceptions," most heartily indorsed by those who have tried it most extensively, the committee considers that its investigation warrants it in most heartily recommending its adoption, and this is fully in accordance with the experience of those members of the committee who have had considerable to do with piecework.

Boiler Jackets.

T. B. Purves Jr., C. G. Turner, E. L. Coster, A. E. Mitchell and J. E. Sague, committee.

The replies [to the question: "How often do you find it necessary to paint steel or sheet iron jackets?"] received from American railways vary between twice a year and once in two and one-half years, but the majority of the replies recommend that jackets be painted every six months.

The Manchester, Sheffield & Lincolnshire Railway paints its jackets about every three years, while the Ferro-Carril Gran Oeste Argentina Railway paints sheet iron jackets every year.

The Norfolk & Western Railway is of the opinion that a planished iron jacket painted over is not so durable as a sheet iron or steel jacket painted; and the Northern Pacific Railway believes that sheet iron jackets should be painted twice as often as those of sheet steel.

The Toledo, Ann Arbor & North Michigan Railroad paints planished iron jackets every 15 or 18 months, and the Delaware, Lackawanna & Western Railroad paints its jackets whenever the gloss begins to wear off, or they show signs of rust.

Some roads paint sheet iron and steel jackets whenever a new jacket is applied, or an old one replaced; or whenever locomotives are painted; or are in the shop for general repairs, say once every 50,000 or 100,000 miles.

It is the almost universal opinion that it is necessary to paint the inside of all jackets prior to application, in order to prolong their life by preserving them from internal rusting and corrosion. This painting is particularly desirable when fresh wood lagging is used, as the aciduous moisture arising from the sweating or streaming of the latter will, especially when the engine is cold, adhere to the jacket surface, and cause quite rapid corrosion of the latter.

The Northern Pacific Railway reports that this corrosive action is more noticeable with sheet iron than with either steel or planished iron jackets; and the Norfolk & Western Railway states that the internal oxidation of unpainted jackets is especially rapid when asbestos cement boiler coverings are employed.

The Chicago, Rock Island & Pacific Railway states that leaking boiler seams are the jacket's worst enemy, although the sweating of the boiler may at times cause moisture to condense on the inside of the jacket and produce oxidation of the latter, if unprotected by paint.

The Baldwin Locomotive Works replies that according to its experience the wearing out of jackets is usually due to the general carelessness of employees in charge of the management and repair of locomotives, no care being taken to prevent jackets from rusting, or from being walked over and hammered out of shape. This is especially the case where wood lagging is used, and has become charred or burned off.

The Chicago & Northwestern Railway states that if the jackets are painted inside when new, and again whenever they are removed, there is practically no internal corrosion; consequently the wear is from external abrasion.

The Union Pacific Railway states that jackets wear out from external abraison, and from corrosion due to acid drippings from the roundhouse roof.

The average of the mean life given in the different replies is 10.57 years, the minimum and maximum life mentioned being 2 years and 12 years.

The Delaware, Lackawanna & Western Railroad reports that it has Russia iron jackets which have been more than 20 years in service, the jackets being now painted.

It is the prevailing opinion that properly painted sheet iron and steel jackets are *less* seriously affected by the acid-laden moisture than are planished jackets, on account of the protection afforded to the former by the paint.

It is claimed by several master mechanics that when a leak occurs in the boiler, the wood lagging permits the steam to spread all under the jacket, while the magnesia and asbestos coverings tend both to confine and absorb the issuing steam and water. The jacket is also far better supported by the latter coverings than by the former; it is therefore less liable to be dented or otherwise mechanically injured, and the possibility of the lagging taking fire is eliminated.

From a careful consideration of the foregoing your committee concludes that it is more economical to use boiler jackets of common sheet iron, or sheet steel painted, than it is to use jackets of planished iron.

Abstracts of the remaining reports will be printed in the next issue.